SCIENCE

A WEEKLY JOURNAL DEVOTED TO THE ADVANCEMENT OF SCIENCE, PUBLISHING THE OFFICIAL NOTICES AND PROCEEDINGS OF THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.

FRIDAY, MARCH 5, 1909

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ADJUSTING THE COLLEGE TO AMERICAN LIFE[1]

FROM a constructive point of view, the existing college represents for the most part tendencies rather than design. It has in the main simply come to be what it now is. True, the gardeners have pruned a bit here and tied up a bit there. But the hedge has been trampled down, and things have been suffered to grow with less regard to the demands of the market than to the fertility of the soil. Provisionally, this style of farming has its advantages. It at least instructs us as to what will grow under given conditions. There comes a time, however, when indiscriminate abundance and variety must submit to a process of evaluation; when wasteful natural productivity is no longer best adapted to meet the demonstrated or calculable needs of a well-defined social organization; when, in a word, we must ask which part of the crop has value, and to what end. This necessity is, I take it, reflected in the question proposed for to-day's discussion.

Two things have happened in higher education during the last thirty years: in the richer and more progressive sections of the country the traditional one-curriculum college has been practically demolished; the graduate school has been evolved. The demolition of the old-fashioned college helped, of course, to make a clearing for the graduate school, and the concurrent growth of the graduate school

[1] An address given before the Section of Education at the Baltimore meeting of the American Association for the Advancement of Science.

hastened the completer demolition of the college. But educationally the two phenomena are not the same. We can neither appreciate nor escape our present plight, until we hold them in thought at arm's length from each other—in thought, for summary geographical sundering of the one from the other is not at this moment advocated, I believe, by anybody.

I say the old college has gone to pieces. But it has not simply gone to pieces, leaving a dust heap to mark its site. It has perished as perishes a frontier town, in the very process of conversion into a modern city. The significant aspects that meet the eye are not so much the evidences of dissolution as the preparations for a new, more commodious and more substantial structure. The college has increased its resources, it has undertaken to serve a far wider range of social activities by frankly conceding the culture-value and dignity of science and of the useful arts. This extension of scope saved it from extinction, at the same time that it procured for the college a far more vital function than it had previously discharged. The historian of our educational history will, I believe, speak of this successful transformation as the great educational achievement of the generation following the Civil War—an achievement destined to be permanently associated with the name and leadership of President Eliot.

On the other hand, from the standpoint of the incoming generation, it is fair to regard the college situation as still undetermined. I have used the word "preparations" advisedly. The college has in hand the elements out of which effective schools may some day actually be made. But they have not been made as yet. Except in the realm of technical education, the college is still almost wholly unorganized. The question inevitably arises whether educational organization at the college level must be limited to the technical field; further, whether it is only the technical instinct that discloses itself during adolescence; finally, whether other types once made out may not be equally amenable to organized educational treatment. In a previous discussion[1] I excluded the technical school, not because it ought to be severed from the college, but because criticism aimed at collegiate chaos does not lie as against the technical departments. I hope now to show that, so far from having no bearing on the academic situation, the technical school, whatever its present defects, is really highly suggestive. The college recognizes the technical motive, stimulates and rewards its expression by providing for it adequate and continuous discipline. It has no fear of wrecking a youth who expects to be an engineer by encouraging him to know his mind at eighteen; in other cases, however, it keeps hands off for fear of doing violence to what is deepest in social and individual activity. Hence, the college outside the technical field now almost entirely avoids definite formulation on the educational side. Once a minimum of content and a maximum of organization, it is now a maximum of content and a minimum of organization.

It is as though a great clearing had been made to which stone and timber, lime and sand have been hauled in large quantities. But neither architect nor builder appears. Meanwhile the neighborhood children play at building with the material. They pile up rambling inconsequential structures that quickly collapse into as many shapeless separate heaps. The brick and stone are college courses; the separate heaps represent individual curricula; the children building without eventual purpose are college students; and the utter absence

[1] "The American College," p. 48, etc.

of connective mortar or controlling design is the elective system!

The college development of the last thirty years amounts, then, from our present standpoint, to educational opportunity rather than educational achievement. Meanwhile the graduate school can not be characterized in similarly negative terms. Its activity in accumulating and refining material represents positive achievement of the highest order. But not college achievement; a serious pedagogical misconception is involved in embracing college and graduate work in a single appreciation. Research is essentially a post-collegiate affair. Not, of course, the research-spirit: that belongs to every stage of modern education; it has its place in the elementary school, in the secondary school, in the college, in each of which the pupil gets some of his motive power from an active curiosity, a distinct tension or problem-sense, far more efficacious in disclosing and disciplining power than a didactic routine smacking strongly of authority. When I urge that the college is not the place for research, I do not say that it is not the place for the research spirit; I do not say that originality, initiative, native reaction on the student's part, are not to be sought after. What I mean is that these essential qualities are not developed only in searching or researching for new material; they are just as readily evoked in situations that are old, provided only the situations be real, pressing, vital and in so far novel to the boy. Thus the research spirit freely stimulated through childhood and adolescence provides background and basis adequate both to suggest and to support genuine problems. Lacking this, problems are given to, not felt out by, the student. This distinction can be made with infinite advantage to both college and graduate school. Failure to perceive it has led to the premature forcing of research and research workers upon the college, as if only thus college studies could be vitalized. Of course, if it is true that research can alone keep teachers from outright ossification, haste must be made to introduce it into the secondary and primary schools, where it is equally important to have teachers who can bend without breaking. The fact is, however, that some men have totally dried up while researching; that others keep their effervescent sparkle without research by cultivating an open and ready responsiveness to novelty, regardless of whether it issue out of the narrow limits of the university laboratory or out of the great laboratory of human life itself. It is absurd to ignore the stimulus of modern life at large and to emphasize exclusively the aspects of activity represented by the academic workshop. All the live men are not laboratory investigators; nor are all the investigators keenly alive. Now then, research in the eulogistic and narrow sense concerns itself altogether with the employment by mature intellects of a powerful technique for the express purpose of increasing or refining knowledge. For this sort of thing the graduate school is the proper place; and the graduate school in its brief history has contributed substantially to increase our intellectual store of precious metal.

The college was enabled at a critical juncture to import generously from the newly established and highly productive laboratories and libraries; but the very bounteousness and suddenness of the enrichment operated to hinder the growth of definite conceptions of college function. The lack of adjustment, which our topic confesses, originates just here. The concern of the college is with students, not with stuff. Adjusting the college to life means the pedagogic assimilation and organization of this accumulated and accumulating material; bringing it to bear

in essential social and individual functions. It does not mean pushing the boundaries of science a little farther into the still unexplored regions of the north, but rather employing our scientific resources to make life itself more highly intelligible and satisfying; it means not delving more deeply for such fragments of historic detail as may have hitherto escaped detection, but making our historic and ethical knowledge tell, in comprehending and rationally modifying what now is. This is a different thing from merely mining for additional facts; a different thing from just getting to know the stock on hand. The business of the college is human and disciplinary, formative and cultural. Its important relations are to *society*, not to *knowledge*, as such; relations *through* knowledge, rather than *to* knowledge. Knowledge is its tool, not its end. From the college point of view, knowledge is just so much raw material, and the more refined, abstract, logically separate and complete, the rawer it is; the more it needs reconstruction, digestion, recombination in ways suggested from the boy's side by genetic psychology, from the social side by the forms into which at a given epoch common activities have been differentiated.

Surely this is what "adjustment" means. When we talk of adjusting the college to life, we mean in plain language working out a concrete educational scheme which will adjust each individual boy to the concrete social situation. Of course this is not all we mean. Education is something more than a mere adjustment. It is also concerned with developing demands on the child's part calculated to upset the existing adjustment. The child must be, in a word, fitted to play his part; straightway that part and the actual social order including it offend his awakened rationality. It is then equally the business of education to fit him to assist in further progress. The college is in this respect but the culmination of, not fundamentally disconnected from, the elementary and high schools. Throughout all these stages of growth and adjustment, education contemplates an actual emergency—a here and now, made up of ascertainable factors. Such a situation can be either superficially or profoundly analyzed in the effort to reach its essential constituents. The elementary school analyzes it largely from the physical and impulsive sides. The high school penetrates farther on the civic and ethical sides; on the individual side, it distinctly seeks to exploit the boy in the hope, among other things, of disclosing the particular way in which he can himself function in society. On both sides the college must proceed still further. Individual differentiation on vocational lines comes in the college period still more sharply to the front; simultaneously, it is all the more important, if the college is to make good the alleged breadth of its discipline, to open the boy's eyes to what is characteristic and significant in the life that is to be the background, basis and standard of all his subsequent activity. An educated man is, in a word, a citizen of the world, of his time, of his nation, just as really as he is a member of a craft, a profession, or a union. And he needs specific training for the former as for the latter.

The common backbone of an adequate educational scheme is thus suggested. Practically the best that the college can now count on in this matter from previous education is a fair knowledge of the facts of our own and English history and some appreciation of the workings and ideals of our own institutions. Hence the college is at once confronted with the necessity of working out a common discipline which will give all students alike a wider outlook,

a deeper grasp of facts, a keener sense of their significance. Unless educated men meet upon such common basis and interest, education, instead of bringing our resources to bear most effectively on the conscious purpose of society, tends to detach disciplined minds from each other and from a common object. The high school comes too soon to do this; the professional school too late. A vague sense of this obligation the college still betrays in clinging to catchwords like "broad," "liberal," "training for citizenship," "training for character." But one can lay one's hands on nothing definite in the curriculum that is actually calculated to make for breadth, liberality or citizenship. The subjects are not there; the treatment is distinctly hostile. At best, special, not general, individual, not basic, needs dictate the composition of the student's course of study. Now, without a curriculum organized and presented with this clearly conceived object in view, what reason is there to believe that the student possesses either the intelligence or the impulse to construct for himself a discipline from which he will emerge with the necessary comprehension and disposition? He lacks the requisite knowledge, purpose and intelligence; and as a democratic society aims to realize not instinctive, but rational ideals, it would be strange indeed if every boy who had read Cæsar and studied algebra already felt the sure ethical and speculative solicitude which it is precisely the task and difficulty of education to develop within him. That is a matter which a society endeavoring to realize conscious ideals through its own corporate action does not leave to the discretion of the individual boy. Of course, it will prize the will or instinct, if he chances to possess it; it will set about creating it, however, if he doesn't. Such training is in the highest sense formative, cultural, human. It suggests a field of college pedagogy which will be opened up for settlement and cultivation when the outposts of research are withdrawn to their own proper territory, just as a secondary school pedagogy will become possible when the college vacates its mechanical and unintelligent control. Contemplating this broad general outlook or basis for all college students, regardless of the special activities which as individuals they may pursue, Professor Mann has recently sketched a college treatment of science that falls in completely with this view:

> It would seem, then, that for the normal non-specialist the present instruction in laboratory science, with its wealth of exactness and technical detail, is a misfit. What is needed for these general students in college is a discussion of the bearing of science on the history and present forms of social and economic life, with no laboratory work of the present sort, rather than the customary re-hash of a subject-matter from which the juice should already have been pressed. In other words, the college course in science should try to give to the student who seeks breadth and culture a new and enlarged view of the value and the bearing of science in human life, rather than to fill him with a more detailed and more highly specialized mass of information, which, at his age, ordinarily interests him but little and arouses his enthusiasm even less.
>
> Looked at from this point of view, a course in science in college would be very different from any now given there. If the science were physics, the proposed course might begin with a discussion of the steam engine. Attention should be given to the social and economic changes conditioned by or closely connected with the development of the steam engine, and of its application to manufacture and transportation. When the steam engine was finished, electricity might be taken up in the same way. The electric telegraph and the dynamo and the telephone have certainly affected economic and social life in a powerful way, and played an important part in bringing about present conditions. The entire subject of electricity could easily be brought, if desired, into a discussion of the subject from this point of view. Practical appliances like those just mentioned should not, however, receive all of the attention of the class. The achievements in pure science must not be neglected. Thus the Copernican system of astron-

omy has certainly had a tremendous effect on our intellectual and spiritual life. The important points are briefly these: (1) For the specialist in science or in engineering, college laboratory work of the right sort is an essential part of his professional training. (2) For the non-technical or general student, college laboratory work is neither essential nor desirable; the emphasis in this case should be laid on the services of science in developing and maintaining intellectual, social and economic life.

Thus the college will have made the first step towards a definite adjustment to the conditions of life, when it has worked out a fundamental, common basis which takes up the essential and significant factors of actually extant activities. It has next beyond this a specific duty in reference to each individual, the duty of preparing him for his particular function in just this same society. The particular function of the student must then at this moment be decided: on native lines, if possible, but decided, in any event. As to this I shall have a word to say presently. Just now I point out that the valid scope of election can extend only to such choice of individual function. That choice once made, it is the business of the college to devise the educational procedure that will give it effect. The task is made generally possible of achievement by the fact that modern society has already been differentiated into certain typical forms, a process rapidly going further. The tendency is not without dangers, which would, however, be partly combated by the general cultural procedure already suggested, and partly otherwise. To ascertain what the types in question are and what the lines of training adapted to each, the college must again recur to the existing social situation, in order to discover the forms in which individual energy plays and to work out for each its appropriate pedagogical expression. It is needless to attempt a list of these types now. That again is a task for the college pedagogy yet unborn. Local as well as general conditions here come into play; not impossibly the attempt to recognize and to develop such types may lead to a differentiation among colleges, each of which will then perhaps no longer seek to be all things to everybody. For purposes of illustration, having already touched upon engineering, I confine myself now to the well-defined professions of law and medicine and to trade. In each of these we must organize a curriculum which will constitute an effective preparation for a subsequent training that, once begun, can not afford to concern itself with preliminary matters, and that will also relate the career in question to social life at large. In general, instruction on these lines must be liberally and not just technically conceived. Take the case of medicine. The college will, within its limits, train broadly when, free from any immediate technical responsibility such as exists in the professional school itself, it presents every subject philosophically as well as technically. The student of biology, physics and chemistry is thus on the technical side preparing for the study of medicine; meanwhile the bearing of modern scientific methods and discoveries on the whole trend of social speculation and activity may be simultaneously made clear to him. If we exclude the distractions that are now largely through administrative timidity suffered to consume much of his time and energy, and organize his instruction, as to both substance and method, with a clear notion of what we are driving at, the college years amply suffice for the thorough two-sided treatment of the scientific basis of subsequent medical study.

The argument holds equally in reference to law. I submit that a careful analysis of the function of the lawyer in modern society will suggest a very definite preparation for his career, though the col-

lege now puts no particular pressure upon the future law student to find himself. The lawyer nowadays is two things. He is obviously a practitioner. For this line of activity he can doubtless be admirably prepared by a sharp and severe technical drill in the law school. So far, he is only the clerk of his clients. But he is in reality much more than this. He is the main agent in adapting the great institutional arrangements of society to its progressive movement. As judge and legislator, it is the lawyer who interprets, embodies and guides deep social and ethical currents. True enough, few lawyers as yet appreciate and deliberately prepare themselves to exercise this function; hence their resistant, anti-social, obstructive bias. But the college that seeks to train a race of intelligent broad-gauge men will embrace the opportunity to produce through a profound study of ethical and industrial forces and developments a race of lawyers whose later technical acquisitions and point of view will be conditioned by a large consciousness of their constructive social responsibility. The lawyer is in large measure obstetrician to the future: whether the birth will be painful or gentle depends in no small degree on the skill, intelligence and large-mindedness with which our lawyers frame, apply and judge our laws. We live in a legal and institutional framework that was built to protect us against dangers, many of which no longer exist. Meanwhile totally different emergencies have arisen. The question to be solved through and, to a considerable extent, by our lawyers, is whether these institutions can be adapted to new conditions without interruption of historic continuity. To appreciate their problem, to get in possession of the data bearing on it, the lawyer of the future must rest his specific legal training on an adequate grasp of the tendencies, perplexities and rational ideals that are seeking to utter themselves. Once more, such training must be had in the college, if it is to be had anywhere. I repeat, the high school comes too early; the professional school is too busy and too late. And the training in question must be worked out *for* the boy, not *by* him. That such preliminary training would be in the truest sense liberal as opposed to the immediately technical, vocational or professional, can, I think, not be seriously disputed.

An analogous course of reasoning applies to business. It is perfectly possible even now to organize a course of study calculated to prepare a youth to engage efficiently in commerce and to take broad and intelligent views of the part that at this moment commerce plays in promoting national development and in realizing rational ideals. This, I conceive, would be a liberal, cultural treatment of the trade-motive. That such an attempt would not now be premature, Harvard has proved by organizing a school of business administration. Unfortunately, it is a graduate school, thus illustrating once more the tendency to empty the college of all definite content and responsibility. A student intending to embark in trade is compelled, before he can enjoy the opportunities of the graduate school of business administration, to spend four years in college, doing nothing in particular, before he can at twenty-three get tardy leave to spend two more years preparing to be an intelligent business man. The analogy followed in making the school a graduate school is that of law and medicine: a mistaken analogy, as it seems to me. The student who gets his degree in law or medicine is a lawyer or a doctor. The student who passes through the graduate school of business is not a business man. He has accomplished in reference to business exactly what the preliminary training in biology

and chemistry has done for the intending physician, and analogy would therefore require that the business school become a differentiated college type analogous to the differentiated college types looking forward to law and medicine. The catalogue explains the graduate constitution of the school on the grounds that students must be mature and that the work is specialized and technical. I confess that to me it appears neither more difficult nor more highly specialized than many of the courses provided for undergraduates. Harvard opens to ordinary undergraduates courses in statistics, the economics of transportation, banking and exchange, labor problems, corporation economics, public finance, taxation, railroad practise, principles of accounting, principles of law governing industrial relations, not to mention others like the theory of crises, to which undergraduates may be admitted. Is it possible to make the slightest distinction on the score of difficulty or technicality between the courses just mentioned as open to undergraduates and the following, constituting the business courses, from which they are excluded: economic resources of the United States, industrial organization, banking, railroad operation, municipal business? Neither in the necessary maturity of the students nor in the special or technical character of the topics is there the least difference. The real consideration lies here: the college is so disorganized and usually so averse to definite conception of function and to maintenance of standards adequate to future use, that whatever is serious, organized and definitely purposeful tends to become post-collegiate. Had the college been given to organization and serious standards, the graduate school of business would have made an additional college type resting upon the same general basis as the legal and medical types; and the subjects composing it would be pursued and presented in both their technical and their liberal bearings.

The proposed organization of the curriculum on the basis of differentiated social types differs essentially from the so-called group system. The group system presents combinations on departmental lines: Latin and Greek, biology and chemistry, mathematics and physics. The two subjects forming a group belong, as a rule, closely together, and they enter into combination as linguistic or scientific entities detached as far as may be from practical or social concern—which detachment is, by the way, accounted an advantage from the cultural standpoint. The logical or departmental integrity of the subject becomes thus as prominent in the college as in the graduate school, where conditions and aims are so very different. To my thinking, the college thus goes far towards defeating its own cultural purpose. I do not pretend, of course, that the culture value and the scientific value of biology, for example, are two separable elements; my meaning will be clear from an educational point of view when I say that the cultural importance of biology to the college student comes out when, in addition to his mastery of biological science as such, its history, its applications, its influence on the development of thought, have been explicitly brought forward; when, in other words, the vocational bearing and the social significance of the vocation in question supervene upon the strictly scientific study. Our present college methods of handling science suffer not from too much, but from too little vocational and professional insight. Of course, the vocational handling of biology may readily be just as narrow as the scientific. But an intelligent treatment, such as the college is the place and has the time for, so far from confining the student to mean ends, will open his eyes to

the social and philosophical significance of the activity to which his college studies lead and upon which he will presently embark. Such a treatment the group system, dealing with subjects as subjects, does not essay.

It is, in other words, quite clear that under modern conditions whatever breadth of intelligence the boy attains—and this is, I take it, mainly what is meant by culture—has to be got *through* his activities—social and individual—and not as *against* them or in their despite. This is the fact on which the elective system is based, whether in the unorganized form now in common use or in the organized form which I am urging. So far, a common argument protects both; the diversity of college opportunity corresponds to the diversity of social need. It can not be arbitrarily abridged or reduced. Selection is inevitable; let it be made as economically and effectively as possible. At this point the cultivated man becomes apprehensive. He fears that election dictated by personal bent or professional need may dwarf the student, mind and soul. To some extent this danger will have been frustrated by the common organic basis which, as has been pointed out, should lie below all individual selection whatsoever. Beyond this, the elected studies must be so handled as to avoid the reproach of narrowness. It is in any event inevitable that a rightly elected college course will presage the student's practical destiny. The same factors determine both—capacity or bent, if he has it—otherwise, opportunity, environment. In the common run of cases, unless the student is a Dr. Jekyll in college and a Mr. Hyde out of it, the two phases will be harmonious. The business and glory of the college are then, not stupidly to ignore or vainly to resist the vocational factor, but deliberately to develop in advance its cultural meaning and possibilities. The disappointment with which we now survey results is to be ascribed to our failure to do this very thing.

The main difficulty in putting into operation the policy I have suggested relates to finding proper teachers. I must touch this vital consideration very briefly. The colleges are apt to attribute their pedagogic shortcomings to lack of teachers; I attribute the lack of teachers to the pedagogic shortcomings of the colleges. Our colleges have done little or nothing to develop teachers; they have emphasized, rewarded and competed for specialists. The college function has been lost in the eagerness to encourage research. Now it has at length been found that the two functions are not identical; that men trained to do the one can not equally well do the other. That certain individuals may profitably do both, that the college and the graduate school are closely related, that they may often best flourish in one institution; all this may be admitted, while still maintaining that the crying need of our academic life is for the creation on the part of college authorities of conditions and ideals that will permit a race of college teachers to grow up and to survive.

A college organized along the lines above laid down could, as it seems to me, claim a certain degree of adjustment to modern life, taken as a whole and equally in reference to its constituent activities. I am not unmindful of the fact that such college organization presupposes a different type of secondary school from what we now possess. This opens up a subject I can not now discuss; but I will say this, that an intelligent secondary school pedagogy, such as is already struggling against college pressure to assert itself, may quite conceivably, among other things, succeed in disclosing the youth's essential affinities, dealing with him, as it would, freely dur-

ing the most characteristic and expansive epoch of his life. Despite conditions extremely unfavorable to decisive choice, statistics, roughly compiled for me, seem to indicate that perhaps seventy-five per cent. of the members of the first-year law classes at Columbia and Harvard knew while in college that they would study law afterwards. This would, I think, justify the college in the very definite procedure that I have advocated. In the case of the engineer, the college even now requires an early decision, followed by continuous hard work; it is difficult to see why either the decision or the hard work should be restricted to prospective engineers.

In the last event, supposing that no bent is revealed—and it seems to me absurd to treat the matter as if every schoolboy has some biologically grounded fitness for some one particular calling—I am inclined to believe that it is wasteful and demoralizing to encourage dispersion by the unregulated opportunity to modify, retract and get lost. The college would do better to treat the vagrant with the wholesome rigor that society employs without compunction in the case of the working boy who, in default of a distinct gift or bent, is arbitrarily apprenticed at sixteen. Would it be better if he were maintained as a parasite until such time as he really concluded at his leisure whether he preferred to be a carpenter or a mason?

Several causes have combined to prolong the chaotic condition of the college. In the first place, college administrators have been terrorized or hypnotized by the term culture. For a long while it was identified with a perfunctory knowledge of Latin and Greek grammar and a few books of Cæsar, Xenophon, and perhaps Virgil, and was sharply antithetic to anything that could possibly be of any use. This is mere rubbish. There is possible a liberal or cultural or philosophic treatment of a man's primary practical concern; and the college which does not occupy itself with such interests in just that spirit has lost an important reason for existence. All these antitheses between vocation and culture, science and culture, business and culture, have got to be resolved by a breadth of treatment which absorbs both. Treated in a vital human spirit, every interest of human faculty is culture. The classics may be—and usually are—sterilized so as largely to lose their culture-value; and science may be humanized and thus gain it.

An equally disastrous bogey has been freedom. We are forbidden to adjust the college to existing social conditions through definite organization, subject to revision as society develops, on the ground that the boy can be disciplined to freedom only through freedom. This absolutely negative conception of liberty, having been thoroughly discredited in politics, economics, philosophy, has trekked over into the educational field, after having been shown the door everywhere else. Now in education, as in economics, liberty interpreted as the absence of organization is of provisional service only in relatively brief periods following the abolition of purely arbitrary restrictions. Under such conditions, it allows repressed, ignored, unknown tendencies to disclose themselves; it permits the real factors in a situation to be ascertained, to the end that, once known, they may within limits be controlled in reference to deliberate design. Our real freedom is thus enhanced, not destroyed. We triumph over limitation only by submitting to it. Mr. Santayana says:

> The only artists who can show great originality are those trained in distinct and established schools. It is only in recent times that discoveries in science have been frequent, because natural science until lately possessed no settled method, and no considerable fund of acquired truths. So too in political society, statesman-

ship is made possible by traditional policies, generalship by military institutions, great financiers by established commerce.

To the same effect, President Pritchett has lately said, speaking of education:

> Organization which is wise, which respects fundamental tendencies and forces, which separates incongruous phases of activity, may not only add to the efficiency of educational effort, but may offer a larger measure of freedom than can be hoped for in chaotic and unrelated efforts to accomplish the same ends.

Even in the home of academic freedom the force of these words can be illustrated. For the honor degrees at Harvard are conferred only after the completion of certain correlated and combined courses, selected *for*, not *by*, the student. Does not this fact plainly indicate that where seriousness begins, there some form of enforced coordination begins also?

The objection to negative freedom does not, however, drive us back to positive, but arbitrary restriction. Still less can the difficulty be met by the illogical Yale-Princeton compromise, according to which the student gets practically two years of each—the freshman and sophomore years devoted to conventional restrictions, the junior and senior years to negative freedom, qualified though it is by the inevitable mechanical inconveniences of the time-table and a few departmental sequences. In considering only the two alternatives here in question or their combination in equal consecutive parts, the colleges overlook altogether the organic character of a genuine educational solution.

I should like briefly to touch another essential point. It is absolutely futile to talk of adjusting to life an institution of such easy virtue as our present college. Perhaps its demoralization of standards simply expresses the fact that, as it serves no particular educational purpose, it is immaterial whether the student takes the thing seriously or not. But a college organized on the lines I have suggested has no other choice but seriousness. We still bear traces of our English collegiate origin in the familiar twaddle about the college as a sort of gentlemen factory—a gentleman being a youth free of the suspicion of thoroughness or definite purpose. Now, I grant that as long as a single required course was forced upon every student, it would have been absurd to require the same sort of performance of every one. The prospective don could fairly be held to a standard not applicable to the future country squire. But the elective system —organized or unorganized—knocks the props from under the gentleman, or citizen —as he is sometimes called. It proposes to do for each student what he needs. It is thus illogical not to require a high grade of excellence of all alike. Ineffective performance can no longer be excused on the ground of the irrelevancy of the task. The tolerant attitude of the college towards every form of individual capacity and social opportunity compels a serious treatment on both individual and social grounds.

The fact that the college has so frequently demoralized rather than stimulated occasionally leads men who have been developed by the struggle for opportunity to look upon mere abundance of opportunity as itself disastrous. Our strong man of the last generation had to fight for his chance; and that was the making of him. A costly discipline, to be sure, but not altogether a bad one. To-day, far better opportunities than he fought for are easy and accessible. The struggle of our children must then be not *for* opportunities, but *within* them. The college offers the chance, it makes every concession to individual capacity and disposition. It must demand, therefore, a genuine performance at every point. To make opportunities

abundant and standards low is thoroughly immoral.

Abraham Flexner
Carnegie Foundation for the Advancement of Teaching

A DANGER ARISING FROM THE POPULARIZATION OF THE COLLEGE[1]

I wish to speak of a danger which threatens the American college as the result of changes in the work of the college and in its environment whose joint effect may be summed up in the phrase, "the popularization of the college."

The history of the American college begins about the close of the first third of the seventeenth century, Harvard College having been founded in 1637. The traditional college curriculum, which was not radically changed till about the middle of the nineteenth century, was largely due to the intellectual conditions of the seventeenth century. When Harvard College was founded, there was very little to be studied, beyond the rudiments of a common English education, excepting Latin, Greek and Hebrew and a little mathematics. At that very time Descartes was shaping the outlines of the method of coordinates in geometry, but the world had still to wait half a century for the invention of the calculus. A half-century was to elapse before Newton's great discovery of gravitation gave unity to the conception of the universe. Almost a century and a half was to pass away before the discoveries of Priestley and Lavoisier created the science of chemistry. The "Systema Naturæ" of Linnæus did not appear until Harvard College was already a century old. A century and a half was to elapse before geology and paleontology took shape under the hands of Hutton and Cuvier. It was almost a century and a half before Adam Smith's "Wealth of Nations" laid the foundations of the modern study of economics. It was more than half a century before Locke's "Essay on the Human Understanding" opened the discussions of the modern period of philosophy. More than two centuries were to elapse before the study of language took on a scientific form in Grimm's "Geschichte der deutschen Sprache." Two editions had already appeared of the collected plays of Shakespeare, but as yet no one dreamed of English literature as standing on a par with the great classic literatures as an object of study; and still less would it have occurred to any English-speaking educator to think of the literature of any other modern language as a worthy object of study. The ancient languages and a little mathematics formed about all the educational material that was accessible in the seventeenth century, and it was nothing strange that the curriculum developed in the environment of that age survived for a considerable time after the environment had changed. But the old curriculum has now become thoroughly extinct. The new branches of learning which have developed in the last three centuries have come to take a dominant position in the education of youth, as in the thought of manhood. The wealth of educational material at present available is vastly larger than any one can deal with in the brief years of the college course. Everywhere the fixed curriculum has given place to the elective system. With the recognition that the field of learning is so large that no one can secure even an introduction to all departments of it in the college course, the elective system has become a practical necessity. From the vast variety of attractive and useful studies each student is rightly left to select, in

[1] Address given before the Section of Education of the American Association for the Advancement of Science.

large measure, according to his own idiosyncrasies, tastes and professional plans.

With this change in the studies of the college course has been associated a change in the constituency of the college. In earlier days the fixed curriculum of the college was supposed, rightly or wrongly, to be adapted to furnish the best substratum for the subsequent professional training of men who were dedicated to the three pursuits known as the "learned professions"—the ministry, the law and medicine. The members of these professions formed a sharply defined intellectual aristocracy. Membership in that aristocracy was, in large degree, hereditary. The members of these professions constituted what Dr. Holmes has felicitously called "the Brahmin caste" in the American society of earlier days. For those boys who were not destined for the learned professions, and for all girls, the training of the common schools in the three R's was supposed to be all-sufficient. To-day there is no such Brahmin caste. The aristocratic constitution of society has changed to one which is intellectually, as well as politically, democratic. The academies and high schools teach the rudiments of the new learning to boys and girls who have no aspiration for any specially learned professions, but who are to do the common work of men and women in society. In the changes which have passed over society new professions have developed which rival the old learned professions in their demand for advanced intellectual training. The work of the teacher has been evolved into a distinct profession, instead of being merely an incidental and temporary employment for persons who were ultimately to pass into other walks of life. The applications of science in the various useful arts have created a demand for advanced intellectual training on the part of multitudes of men who are destined not to lives of scholastic seclusion, but to lives whose business is with the concrete realities of the material world. There is no sharp distinction between a learned class and an unlearned mass; there is rather an indefinite gradation from the most educated to the least educated members of the community. Now that the sciences of nature, the modern languages and literatures, history, economics and sociology have assumed a dominant position in the college course, the college attracts to itself a much wider and more varied constituency. Not alone the devotees of the ancient learned professions, but multitudes of those who are going into the variety of pursuits embraced under the general name of business, throng to the college, and find there instruction and training which will fit them for larger views of their own calling and for broader service as citizens. The college community has become relatively heterogeneous.

Precisely herein lies the danger to which I have thought it worth while to call your attention. In the olden time it was assumed that every student in college was dedicated to a distinctively intellectual pursuit. His life was to be a scholarly life. Hence a scholarly aim, more or less definitely conceived and more or less consistently maintained, during the college course, was expected on the part of all. Now a large share of college students are looking to something very different from a life of learned seclusion. They are to be in the busy world of affairs; they are to develop the material wealth of the community. The careers for which they are intending to fit themselves will demand intellectual vigor and, in many cases, a considerable degree of special knowledge; but they are not careers that would naturally be called scholarly. Hence there comes a pressure exerted upon college faculties to tolerate a lower standard in the scholastic

work of the college, on the ground that a large part of the young men enrolled in the college have no intention of giving themselves to scholarly pursuits, and can not be reasonably expected to have a scholarly spirit. The trouble is not simply that some men do not study. That was always the fact. No system ever fulfills its own ideal; and in the old days, when it was supposed that all students were preparing to be scholars, the supposition was very far from being exactly in accordance with the reality. But then the men who did not study knew and confessed that they ought to study. Now it is gravely asserted in influential quarters that many students in college ought not to study to any very great extent, and ought not to be expected to study; that, as they are never intending to be scholars, there is no need of their being particularly scholarly even during their school life. Precisely on this ground, then, there is a pressure not only on the part of friends of particular students, but also on the part of influential alumni and alumni clubs and associations, to admit men who are unprepared, to tolerate men who are neglecting their work, and to graduate men who have accomplished very little in the line of study. Especially is such a pressure exerted in behalf of men who are distinguishing themselves as athletes during their school and college life, and in behalf of men who are likely to come into possession of considerable money. In urging the claims of such men for peculiarly lenient treatment in college, it is seriously maintained that it is a good thing for men who are going into business, or any other pursuit not distinctly scholastic in character, to go to college with no intention of doing any considerable amount of studying, and to be graduated without having done any considerable amount of studying. It is urged that, if they spend the four years essentially in the avocations of student life—athletics, social events, amusements, college politics—and, in the occasional intervals of leisure which these exhausting avocations may afford, study enough to pass examinations and to be graduated *speciali gratia,* they will yet absorb from the general atmosphere of the college an influence in the direction of increasing breadth of view and higher ideals in life which will be worth the cost in time and money. I do not believe that this view finds much support among college faculties; but I do believe that continual pressure in this direction actually tends to secure the admission of men with lower standards of preparation, and the graduation of men with lower standards of scholarly achievement, than would otherwise be tolerated. The whole position seems to me radically wrong. The business of a student is to study; and for the individual student to spend the four years in the vocation, and to devote the bulk of his continual and systematic neglect of his time and mental energy to the avocations of student activities, is essentially demoralizing. He leaves college with a weakened sense of responsibility, and a conscience which has grown increasingly tolerant of self-indulgence. He has suffered a distinct loss in those elements of strength of character which qualify a man for noble achievement in any department of human life.

If the evil effect were confined to the individuals directly concerned, it would be less serious than it actually is; for a class of men who are in college not to study but for other purposes, exerts an influence upon the college body in the direction of degradation of scholarship and deterioration of character. Especially strong is this evil influence if the men concerned possess athletic ability, wealth, attractive manners and amiable social

qualities which result in their being recognized as social leaders.

Besides the general pressure in the direction of leniency as regards the standards of admission and graduation, the notion that it is desirable to fill up our colleges with a class of students who have no serious ambition to study, has created a tendency to the more liberal admission of students on special courses. I think there would be substantially unanimous agreement among college faculties in the belief that there ought to be some persons admitted as special students. The opportunities of instruction which a college affords can, without any detriment to those who are taking regular courses leading to a degree, be afforded to certain classes of students whose age, financial condition or other circumstances may make it entirely impracticable for them to complete the college curriculum. Teachers in high schools and similar institutions can often get leave of absence for a year, or for a part of a year, and improve the time in earnest study in college in a department in which they are teaching, and in which they have already attained a proficiency which fits them to take advanced work in college. Men and women engaged in various professional or technical pursuits may, in like manner, gain very much by special courses in the colleges in lines of study connected with their work. In such cases, though the persons may not have completed any of the prescribed courses of preparation for college, they are yet fitted by maturity of age, definiteness of purpose and thorough training along some lines of study or intellectual work, to take up the studies of some departments with great advantage to themselves, and with positive benefit rather than loss to the college. It is sometimes justifiable to admit as special students those who wish to take a somewhat general course of study similar to that which would be required for the bachelor's degree, but whose preliminary schooling has been irregular, and who have not covered exactly any prescribed course for admission to college, though the aggregate of training which they have received may be equal in amount or even superior to that which would fit them for admission to college. This is the case sometimes with those who have commenced professional or technical studies and subsequently awake to the necessity of gaining more of general education. In some cases it is legitimate to admit as special students candidates who are expected eventually to get into a regular course of study and take a degree. But to smuggle into college under the name of special students candidates who have simply made a failure of the preparatory course, through lack of ability or through lack of industry, is an evasion which can not be practised without demoralization of the college. But there are probably very few administrative officers or committees having charge of the admission of students to college, to whom the outside pressure for the practise of such evasions has not come to be a familiar experience.

The principle must be explicitly affirmed, and consistently and at times sternly maintained in practise, that, however widely diversified may be the college course under the operation of the elective system, and however cordially men and women preparing for careers widely different from those involved in the traditional learned professions may be welcomed to college, only those students are welcome who come to study—who feel the genuine vocation of the student, and in whose plans for the years of college life the avocations of student life are to be distinctly subordinate to the great vocation. Within limits by no means narrow, they may study what they please; they may shape their

course very largely with reference to the non-scholastic pursuits which await them after leaving college; if they do not want to study Greek, they may study French or German or Spanish; they may study applications of science, as well as pure science; if they do not want to study philosophy or advanced mathematics, they may study the labor problem, or banking and currency, or commercial geography and commercial law: only let it be understood that whatever they profess to study they must really study. In a college, as in a railroad station, there is no room for loafers.

WILLIAM NORTH RICE

THE PALEONTOLOGICAL SOCIETY

FOR some years there has been a growing desire among paleontologists for a society in which students of all branches of paleontology can unite for the promotion of their common interests. Such an organization has now been effected as a section of the Geological Society of America under the name of "The Paleontological Society."

The preliminary correspondence which was begun by Professor Charles Schuchert, of Yale University, early last year, was inspired by the successful meeting of the American Society of Vertebrate Paleontologists in New Haven. This correspondence developed the fact that nearly 60 paleontologists are ready to unite in a general society, and of these, 34 attended the first meeting for organization in Baltimore on December 30, 1908. At this meeting an Executive Committee, consisting of Charles Schuchert, F. B. Loomis, S. W. Williston, David White, H. F. Osborn and T. W. Stanton, was appointed with full power to act for the society.

On February 13, 1909, the Executive Committee met with a special committee of the Geological Society of America in the American Museum of Natural History, New York City, and made a satisfactory adjustment of the relations between the two societies. The committee also prepared a constitution and by-laws and elected the following board of officers for the Paleontological Society to serve the remainder of this year:

President—John M. Clarke.
First Vice-president—John C. Merriam.
Second Vice-president—Timothy W. Stanton.
Third Vice-president—David White.
Treasurer—William D. Matthew.
Secretary—Herdman F. Cleland.
Editor—Charles R. Eastman.

It is expected that all the paleontologists of North America will be enrolled in the membership of the new society before next winter, when its first regular meeting will be held with a full program of papers.

T. W. STANTON

ENGINEERS OF WISCONSIN FORM STATE SOCIETY

THE organization of the Engineering Society of Wisconsin was completed at the first meeting, held at the University of Wisconsin February 24–26, at which some 150 city engineers, general managers of power and traction companies, contracting engineers, superintendents of water and light plants, mechanical and civil engineers, and superintendents of highway construction were present and became charter members.

The officers elected were: *President,* Dean F. E. Turneaure, College of Engineering, University of Wisconsin; *Vice-president,* City Engineer McClelland Dodge, of Appleton; *Trustees* for two years, B. F. Lyons, assistant general manager of the Beloit Gas and Electric Co., and E. P. Worden, mechanical engineer of the Prescott Steam Pump Co., Milwaukee; *Trustees* for one year, E. Gonzenbach, of the Sheboygan Electric Light and Power Co., and City Engineer E. R. Banks, of Superior. These, as executive board, will elect the secretary later.

The new organization will hold annual meetings hereafter for the purpose of bringing together the engineers from all parts of the state interested in the solution of such problems as arise in connection with municipal plants, large construction work, bridge, forest and water-power questions, and light and power production. A wide range of subjects

was included in the program for the initial meeting of the society.

At the opening session, February 24, following the address of welcome by President Charles R. Van Hise, was a presentation of the scope of the highway work of the State Geological Survey, by W. O. Hotchkiss, highway engineer for the survey. A. R. Hirst, also of the state highway department, spoke on the use of tar, oils and emulsions on macadam and earth roads. The discussion on pavements was led by McClelland Dodge, city engineer of Appleton, and participated in by P. H. Connelly, city engineer of Racine; W. G. Kirchoffer, consulting engineer, Madison, and others. City Engineer C. V. Kerch, of Janesville, spoke on the construction of the Court Street bridge in that city.

Interest in the discussion of the conservation of forests and water resources of Wisconsin, a subject presented by State Forester E. M. Griffith, waxed so keen that the paper on "The Water-power Resources of the State," by Professor L. S. Smith, who is engineer for both the state and national geological surveys, was postponed to the following evening. The conservation discussion was led by Senator T. W. Brazeau, and Senator E. E. Brown, Assemblyman J. R. Jones and Professor D. W. Mead also spoke on the subject.

Professor W. D. Pence, who is engineer for the Wisconsin Railroad Commission, opened the second day's program with a description of the organization of the commission's engineering staff. The new problem of standards of gas and electric service was discussed by Professor C. F. Burgess, of the department of applied electrochemistry at the university, who has done important work in enabling the state railroad commission to prescribe a standard for fuel and illuminating gas.

The electric interurban roads of Wisconsin were made the subject of an address by F. G. Simmons, superintendent of construction and maintenance of way for the Milwaukee Electric Railway and Light Company. The day circuit for small towns was discussed by Professor J. W. Shuster, and new forms of arc lamps by W. E. Wickenden, also of the electrical engineering department. Dean Turneaure took the members of the society through the engineering experimental laboratories, explaining the work that is being done there in many lines of research.

The second night was given to a discussion of water powers, W. G. Kirchoffer describing the water supply of the city of Marshfield, and Professor D. W. Mead the subject of hydraulic and hydroelectric power development. Papers on "The Waterproofing of Concrete," by F. M. McCullogh, city engineer of Stoughton; "Municipal Engineering in the Orient and in Porto Rico," by J. T. Hurd and Edwin Wray; "Gas Producers and Small Power Stations," by V. E. McMullen, Beloit, and C. T. Atkinson; and "Madison's Concrete Storm Sewer System," by City Engineer John F. Icke, concluded the convention program.

THE DARWIN CENTENARY

To commemorate the centenary of the birth of Charles Darwin, Professor Vines, Professor Poulton and Professor Bourne gave an "At Home" to the university in the Examination Schools, Oxford, on February 12. There was a large and distinguished gathering, including four of Charles Darwin's sons—Mr. William Darwin, Sir George Darwin, Mr. Francis Darwin and Major Leonard Darwin. Books, letters, etc., of Charles Darwin were shown by Mr. R. W. T. Günther (Magdalen), and Professor Poulton made an address on "Fifty Years of Darwinism." Sir George Darwin and Mr. Francis Darwin briefly addressed the gathering.

THE Darwin centenary was celebrated at Shrewsbury, his birthplace, under the auspices of the Shropshire Natural History Society. Dr. Cosmo Melvill presided, and Dr. Hoyle, of Manchester University, gave an address on Darwin.

THE special business of the meeting of the Academy of Natural Sciences, of Philadelphia, held February 16, was the commemoration of the centenary of the birth of Charles Darwin and of the fiftieth year of the publication of the "Origin of Species." The president, Dr. Samuel G. Dixon, spoke of the in-

fluence of the doctrines of natural selection and evolution on the development of thought and the progress of humanity. Dr. Arthur Erwin Brown, one of the vice-presidents, referred to the fact that the academy had been the first society in America to recognize the importance of Darwin's work and quoted from his letter to Lyell, of May 8, 1860,in which he says: "This morning I got a letter from the Academy of Natural Sciences of Philadelphia, announcing that I am elected a correspondent. . . . It shows that some naturalists there do not think me such a scientific profligate as many think me here." Dr. Brown also read a letter addressed by Darwin to Dr. Joseph Leidy, under date of March 4, 1860, acknowledging receipt of publications, expressing appreciation of Dr. Leidy's work and returning thanks for his support of the doctrine of natural selection. Dr. Edwin G. Conklin, also vice-president, then read a memoir of Darwin dwelling on the importance of his work in science and on the relation of the doctrine of natural selection to modern thought. A collection of Darwin's works and his letter of acknowledgment of election as correspondent of the academy were exhibited.

The biological and botanical departments of Brown University held a meeting commemorative of the Charles Darwin Centennial on February 12. The program was:

Introductory remarks with exhibition of portraits of Darwin and his contemporaries, by A. D. Mead.

"Darwin's Relation to Theories of Heredity," by Professor W. E. Castle, of Harvard University.

"Darwin's Influence on Practical Breeding in the Work of Luther Burbank," by Dr. George H. Shull, of the Carnegie Institution, Station for Experimental Evolution.

The State University of Iowa celebrated the Darwin Centennial by two addresses at the assembly of all colleges. Professor C. C. Nutting spoke upon the personal traits of Darwin, and Professor T. H. Macbride upon his contributions to botany. The Baconian Club devoted its evening program to the memory of Darwin and addresses were made on his contributions to zoology, botany and psychology by Professors G. L. Houser, B. F. Shimek and C. E. Seashore, respectively.

The Society of Arts held a meeting in commemoration of the birth of Charles Darwin at the Massachusetts Institute of Technology. Addresses were made by Professor William T. Sedgwick, of the biological department, and Professor Percival Lowell, non-resident professor of astronomy at the institute and director of the Lowell Observatory at Flagstaff, Ariz.

THE CARNEGIE FOUNDATION FOR THE ADVANCEMENT OF TEACHING

Two special recommendations have been made by the executive committee of the Carnegie Foundation to the board of trustees and, having been adopted by the board, have been incorporated in the rules of the foundation. By one of these recommendations the maximum amount of a retiring allowance is raised from $3,000 to $4,000, and by the other the executive committee is directed to grant a pension to the widow of a professor in an accepted institution who has been for ten years married to the professor, the pension to be one half of what the husband would have been entitled to receive. Heretofore the pensions to widows have been only permissory. They have now been raised from discretionary ones to a certain provision by the adoption of the following rule:

Any person who has been for ten years the wife of a professor either in receipt of a pension or entitled to receive one shall receive during her widowhood one half of the allowance to which her husband was entitled.

The rules for the granting of retiring allowances in force January 4, 1909, are as follows:

A normal retiring allowance is considered to be one awarded to a professor in an accepted college, university or technical school, on the ground either of age or of length of service. The term professor, as here used, is understood to include presidents, deans, professors, associate professors and assistant professors in such institutions of higher learning.

In reckoning the amount of the retiring allowance the average salary for the last five

years of active service shall be considered the active pay.

Retiring allowances shall be granted under the following rules, upon the application of the institution with which the professor is connected. Application blanks for this purpose are furnished by the foundation. The ground upon which the application is recommended, whether it is upon the basis of age or upon the basis of service, should be stated in each case.

1. *Basis of Age.*—Any person sixty-five years of age, who has had not less than fifteen years of service as a professor and who is at the time a professor in an accepted institution, shall be entitled to an annual retiring allowance, computed as follows:

(*a*) For an active pay of twelve hundred dollars or less, an allowance of one thousand dollars, providing no retiring allowance shall exceed ninety per cent. of the active pay.

(*b*) For an active pay greater than twelve hundred dollars the retiring allowance shall equal one thousand dollars, increased by fifty dollars for each one hundred dollars of active pay in excess of twelve hundred dollars.

(*c*) No retiring allowance shall exceed four thousand dollars.

Computed by the formula: $R = A/2 + 400$ where R = annual retiring allowance, A = active pay.

2. *Basis of Service.*—Any person who has had a service of twenty-five years as a professor, and who is at the time a professor in an accepted institution, shall be entitled to a retiring allowance computed as follows:

(*a*) For an active pay of twelve hundred dollars or less, a retiring allowance of eight hundred dollars, provided that no retiring allowance shall exceed eighty per cent of the active pay.

(*b*) For an active pay greater than twelve hundred dollars, the retiring allowance shall equal eight hundred dollars, increased by forty dollars for each one hundred dollars in excess of twelve hundred dollars.

(*c*) For each additional year of service above twenty-five, the retiring allowance shall be increased by one per cent. of the active pay.

(*d*) No retiring allowance shall exceed four thousand dollars.

Computed by the formula: $R = A/100(b + 15) + 320$ where R = retiring allowance, A = active pay and b = number of years of service.

3. Any person who has been for ten years the wife of a professor either in receipt of a pension or entitled to receive one shall receive during her widowhood one half of the allowance to which her husband was entitled.

4. In the preceding rules, years of leave of absence are to be counted as years of service, but not exceeding one year in seven. Librarians, registrars, recorders and administrative officers of long tenure, whose salaries may be classed with those of professors and assistant professors, are considered eligible to the benefits of a retiring allowance.

5. Teachers in the professional departments of universities, whose principal work is outside the profession of teaching, are not included.

6. The benefits of the foundation shall not be available to those whose active service ceased before April 16, 1905, the date of Mr. Carnegie's original letter to the trustees.

7. In counting years of service toward a retiring allowance, it is not necessary that the whole of the service shall have been given in institutions upon the accepted list of the foundation.

8. In no case shall any allowance be paid to a teacher who continues to give the whole or part of his time to the work of teaching as a member of the instructing staff of a college or technical school.

9. The Carnegie Foundation for the Advancement of Teaching retains the power to alter these rules in such manner as experience may indicate as desirable for the benefit of the whole body of teachers.

SCIENTIFIC NOTES AND NEWS

THE Berlin Academy of Sciences has awarded its Helmholtz medal to Professor Emil Fischer, for his work on the sugars and albuminoids.

DR. FRANK D. ADAMS, dean of the faculty of applied science and professor of geology at McGill University, has been elected an honorary life member of the Institute of Mining and Metallurgy of Great Britain.

THE Royal Society of Arts has presented its Albert medal to Sir James Dewar, F.R.S., for his investigations into the liquefaction of gases and the properties of matter at low temperatures.

THE managers of the department of archeology of the University of Pennsylvania have awarded the Lucy Wharton Drexel medal, for

important work in exploration and publication, to Professor Rudolph E. Brunnow, for his work in Assyria and in the exploration of Arabia.

Mr. Arthur Hill, regent of the University of Michigan, has made the offer to the board of regents of a bronze or marble bas-relief of President James B. Angell, in commemoration of his eightieth birthday and the valuable services which he has rendered to the university, state and nation. The monument will be placed in the new Memorial Hall.

Dr. Edgar F. Smith, professor of chemistry and vice-provost of the University of Pennsylvania, is recovering from a somewhat serious illness.

Dr. C. C. Clark, associate statistician of the Department of Agriculture, has accepted an appointment as chief of the Bureau of General Statistics and Agricultural Information in the International Institute at Rome.

At the annual meeting of the Royal Astronomical Society on February 12 Mr. H. F. Newall, the president, extended a cordial welcome to Professor O. Backlund, director of the observatory, Pulkowa, Russia, to whom the society's gold medal had been awarded. The Jackson-Cwilt bronze medal and gift were handed to Mr. P. Melotte, of the Royal Observatory, Greenwich, in recognition of his discovery of the eighth satellite of Jupiter. Sir David Gill was elected president of the society for the coming year; Sir W. H. M. Christie and Messrs. J. W. L. Glaisher, H. F. Newall and H. H. Turner, vice-presidents; Major E. H. Hills, treasurer; Messrs. A. R. Hinks and S. A. Saunder, secretaries, and Sir W. Higgins, foreign secretary.

Mr. Eckley Brinton Coxe, Jr., founder of the Coxe archeological expedition from the University of Pennsylvania, and Dr. George B. Gordon, curator of the museum, have sailed for Egypt to join members of the expedition who are working in Nubia.

Dr. J. K. Small, head curator of the museums and herbarium of the New York Botanical Garden, accompanied by Mr. J. J. Carter, of Pleasant Grove, Pa., has been in south Florida for botanical exploration and collecting on the everglade keys, in continuation of his previous work in that region and his studies of the plants of the southeastern United States. Dr. J. A. Shafer, museum custodian in the garden, is in Cuba, commissioned to spend about three months collecting in the northeastern portion of that island, which has been little visited by botanists.

Dr. Hiram Bingham, Jr., instructor in Latin-American history at Yale University, who is now in southern Peru on his South American trip of historical research, is reported to have made important discoveries of Inca remains near Abancay, Peru.

A meeting of the Columbia Chapter of the Society of Sigma Xi was held on March 4 in Fayerweather Hall. "The Sanitary Protection of Tidal Waters" was the topic of the evening, and George A. Soper, C.E., Ph.D., president of the Metropolitan Sewerage Commission, the lecturer. The address described the harmful consequences resulting from the discharge of sewage into tidal harbors and the measures taken to prevent excessive pollution.

Mr. W. H. Finley, assistant chief engineer of the Chicago and Northwestern Railway Company, gave a lecture before the College of Engineering of the University of Illinois on Friday, February 19 on "The Quebec Bridge Failure."

At the 658th meeting of the Society of Arts, Boston, on February 27, Professor Charles E. Lucke, of Columbia University, made an address on the subject of internal combustion engines.

President Taft gave the annual Washington's Birthday oration at the University of Pennsylvania, being presented by the governor of the state. Among those on whom the doctorate of laws was conferred was Dr. Samuel G. Dixon, formerly professor in the university and now Commissioner of Health in the state of Pennsylvania.

President Hadley, of Yale University, made the commemoration day address at the Johns Hopkins University on February 22, which was entitled "Two Sides of University Life."

PROFESSOR E. S. MORSE lectured at Tufts College on February 24 on "Natural Selection and its Application to the Darwinian Theory of the 'Survival of the Fittest.'"

PROFESSOR LIGHTNER WITMER, of the University of Pennsylvania, is giving this term a course of lectures on psychology to the fourth year students of the medical department.

EDWIN KATZENELLENBOGEN, Ph.D. (Leipzig), assistant physician at the Danvers Hospital for the Insane, and fellow for research in logic at Harvard University, is to give a course of lectures on psychopathology, consisting of a treatment of selected topics in abnormal psychology. These lectures, which will be open primarily to graduate students, will occupy one hour and a half weekly. In each month three of the lectures will be delivered in the Psychological Lecture Room; the remaining exercise each month will take place at the Danvers Hospital for the Insane, at Hathorne. Special attention will be given to the legal aspects of psychopathology.

THE Kaiser Wilhelm has recalled his veto of the Virchow monument design and has approved the second sketch. The monument will now be erected on the Karl Platz near the Charité.

DR. WILLIAM TILLINGHAST BULL, professor of the practise of surgery at Columbia University and one of the most prominent surgeons in New York City, died on February 22, at the age of fifty-nine years.

THE death is announced of Sir George King, F.R.S., late director of the Botanical Survey of India, aged sixty-eight and of Professor Julius Thomsen, president of the Royal Danish Society of Science, aged eighty-two.

THE "sundry civil" bill for the fiscal year 1910, as reported to the House of Representatives February 19, provides for a new building in Washington to accommodate the Geological Survey, the General Land Office, the Office of Indian Affairs and the Reclamation Service, to cost $2,500,000, and appropriates $100,000 for preliminary work in construction. The site named in the bill is the square bounded by E and F and Eighteenth and Nineteenth streets, west of the building occupied by the State, War and Navy departments and about three blocks west of the White House. For twenty-five years the survey has occupied a rented building on F Street, in the heart of the business section of the city, the annual rental of which now amounts to $34,900. This building is not fireproof and has been three times visited by destructive fires, the last one, in December, 1908, burning government property worth $15,000. The annual rentals paid by the survey and the Reclamation Service amount to about $43,000, and the provision made for the Indian and Land offices in the new building will permit the transfer of other bureaus, now in rented quarters, to a building owned by the government. The annual net saving accomplished will be $51,400.

THE Yale *Daily News* has made a statistical study of the early training of the 15,142 men, sketches of whose lives appear in Appleton's Cyclopedia of American Biography. 5,326 of these prominent men are college trained, with the colleges, credited with over one hundred, represented in the list as follows: Harvard, 883; Yale, 713; Princeton, 319; Dartmouth, 208; Columbia, 198; Brown, 189; Union, 188; Pennsylvania, 175; Williams, 157; Bowdoin, 104; Amherst, 102. Yale's honor roll is divided among the professions as follows: clergymen, 194; lawyers, 149; educators, 83; statesmen, 55; authors, 53; doctors, 43; scientists, 38; soldiers, 37; business men, 19; journalists, 15; in government service, 14; philanthropists, 6; artists, 4; inventors, 3.

WE learn from the *Journal of the American Medical Association* that the International Bureau of Public Health was formally inaugurated at Paris on November 10, 1908, and the director and secretary were installed in office by the committee, composed of one representative from each of the countries which have agreed to support the newly created bureau. Dr. S. B. Grubbs, of the Public Health and Marine Hospital Service, was the United States delegate. The idea of having a central and international office for the purpose of gathering and distributing information concerning the graver epidemic diseases,

especially cholera, plague and yellow fever, was first presented for consideration at the international sanitary convention of Paris, in 1903, although it had been advocated for some time previously by many sanitarians, notably the late Professor Proust, of Paris. At the request of the convention of 1903, the French government undertook the task of presenting to the nations interested propositions regarding the organization of such a bureau. These propositions were submitted in a final form in August, 1907, and a conference was invited by the government of the French republic, at the instance of the Italian government. This conference was held at Rome, December 3, 1907, the delegates signing for the governments of Belgium, Brazil, Spain, the United States, the French republic, Great Britain and Ireland, Italy, the Netherlands, Portugal, Roumania, Russia, Switzerland and Egypt. It is believed that the exchange of ideas that will take place at the semi-annual gathering of the governing committee will have a beneficial effect on international sanitation. In organization the bureau resembles the permanent International Postal Bureau and the Bureau of Weights and Measures.

In a letter to the editor of the Yale *Alumni Weekly*, in reply to a notification of his accession to the title of oldest living graduate of the university, Chester Dutton, '38, wrote recently as follows:

The position of Oldest Living Graduate is *very temporary* About seven years ago it fell to my early neighbor & friend Mr. L. W. Cutler of Watertown Conn, (Yale 1829), who was a perfect specimen of physical manhood, as well as a man without faults and without enemies, and he held it, I think, for a few weeks.

I recall that more than seventy years ago both Prof. Silliman & Prof. Olmsted predicted many of the wonderful utilities of present day life—Both discussed photography and telegraphy and the use of electro magnetism for power as assured results, only waiting on human ingenuity for methods of production and application. The Ocean Steamer however, the Ocean Cable, & the telephone and the skyscraper—and electrical lighting were not talked of; perhaps not thought of. One problem then regarded with much concern was the future supply of light, as the *whales* were becoming scarce. Petroleum was peddled for *medicine* in pint bottles under the name of "rock oil from Kentucky"—Friction (or explosive) matches had come into use about 1834 or 5, 100 matches in a little box, for 25 cents. Prof. Silliman suggested the probable necessity of governments prohibiting their manufacture & sale, on account their possible use by incendiaries.

UNIVERSITY AND EDUCATIONAL NEWS

At the exercises on February 22 in commemoration of the founding of Johns Hopkins University, which opened thirty-three years ago, it was announced that the gift of Mr. Henry Phipps, of New York, for the psychiatric clinic was considerably in excess of $1,000,000.

A gift of $200,000 to the University of Pennsylvania from an anonymous donor was announced at the exercises on Washington's birthday by provost Harrison. It will be used to establish a department of medical research. The gift was received through Dr. John H. Musser, of the faculty of medicine.

The sons and daughters of the late Mr. and Mrs. F. C. A. Denkmann, of Rock Island, Ill., have promised to give a library building to Augustana College and Theological Seminary, Rock Island, the building to cost not less than $100,000, and to be known as "The Denkmann Memorial Library."

By the will of Dr. Gordon W. Russell, of Hartford, class of '34, Trinity College, receives $5,000 for the natural history department and a collection of books on that subject.

An addition has been made to the observatory building at the University of Michigan, including a new dome 40 feet in diameter. The university is also installing a large reflecting telescope which is now approaching completion, and has been designed especially for photographic and spectroscopic work.

Comer Hall, the new engineering building of the University of Alabama, will be ready for occupancy about May 1. It is a large structure of two stories with a ground-floor space something over three quarters of an acre, and will accommodate the departments of civil, mechanical, mining and electrical

engineering and physics. The cost of the building and equipment will be $150,000. Smith Hall, named for Professor Eugene A. Smith, of the chair of geology, is also nearing completion, and will be occupied by the departments of geology and biology. This building will cost $100,000. An academic building, to be a duplicate of Smith Hall, will be begun in the near future.

AT a session of the committee on education of the Massachusetts legislature on February 24 the establishment of a "Massachusetts College" was considered. The aim of such an institution was explained by Mr. Courtenay Crocker, Mr. Edmund D. Barbour and Professor Thomas A. Jaggar, to be to carry higher education to people not in a position to seek its seats at colleges and universities, to give it at a cost which would bring it within reach of those in less than moderate circumstances, and to furnish a training which would justify the awarding of the degrees of A.B. and A.M. Mr. Barbour has offered to give $100,000 to promote the plan.

THE trustees of Wesleyan University have voted to abolish coeducation in the institution after the class entering in the fall of 1909. It is planned, however, to establish in connection with the university a college for women.

MR. SAMUEL W. MCCALL, congressman from Massachusetts, has declined the offer of the presidency of Dartmouth College.

LORANDE LOSS WOODRUFF, Ph.D. (Columbia), has been advanced to an assistant professorship of biology in Yale University.

ASSISTANT PROFESSOR ROBERT W. HALL has been promoted to the professorship of biology at Lehigh University.

MR. LOUIS A. HERDT, associate professor of electrical engineering at McGill University, will succeed Professor Owens in the chair of electrical engineering.

THE electors to the Waynflete professorship of mineralogy at Oxford have elected Dr. Herbert Lister Bowman, M.A., D.Sc., New College, to the professorship in the place of Dr. Henry A. Miers, D.Sc., fellow of Magdalen, who resigned this chair last October, on his election to the principalship of London University.

DISCUSSION AND CORRESPONDENCE

FOREST PRESERVATION

TO THE EDITOR OF SCIENCE: In a recent number of an engineering paper appears an editorial entitled, "How 'Concrete Lumber' Has Made Forest Preservation a Farce." The article opens with the following words:

> The fast-perishing forests of America have been the theme of many a statistical lament. "Behold the loss of all this wealth, this criminal waste of natural resources!" cries the statistician, until we find ourselves almost sniffling in sympathy. Amid all this *illogical agitation* (sic) for forest preservation it is well to turn an eye toward the timber of the future "concrete lumber" as it has been aptly called, etc.

Are we to understand that engineers and contractors are willing to look forward to a concrete age, which will be independent of the waste of natural resources? The statistician tells us that the production of cement in 1890 was 335,000 barrels; in 1907 it was 52,000,000 barrels, worth $56,000,000. Will some one tell us how many tons of coal will be required to manufacture the cement which the world will require during the present century? And then will some one go farther and estimate how many board feet of lumber are likely to be used to make the forms required for concrete construction? The organized effort which is now being made to educate the people, so that wasteful extravagance shall cease, should receive the hearty support of the engineering profession and press. The following statement of Dr. I. C. White, state geologist of West Virginia, is likely to become classic and can not be too often reprinted:

> Just as sure as the sun shines and the sum of two and two is four, unless this insane riot of destruction and waste of our fuel resources which has characterized the past century shall be speedily ended, our industrial power and supremacy will, after a meteor-like existence, revert before the close of the present century to those nations

that conserve and prize at their proper value their priceless treasures of carbon.

Allerton S. Cushman,
Assistant Director
Office of Public Roads,
U. S. Department of Agriculture

MAGNETIC ROCKS

While in southern Arkansas recently, studying the northern outcrops of the oil-bearing horizons of Louisiana, I took occasion to ascertain whether the peridotite eruptives about Murfreesboro, Arkansas, were as magnetic as similar rocks in central New York. They prove to be so; hence it seems that if a somewhat detailed magnetic survey of the region thereabout were made the tens of thousands of dollars now expended in worthless options might practically all be saved. Naturally in searching for diamonds the first information desired is the whereabouts of the volcanic necks bearing the diamond dirt. Though these are covered by plateau gravel or alluvial sands and clays they can be detected as readily as the dikes in central New York can be located though under many feet of glacial till.

G. D. Harris,
Geologist to Louisiana

A NEW PHENOMENON IN ELECTRIC DISCHARGE

During last May the writer used a wire of platinum having a diameter of 0.005 cm., in some work in electric discharge around a right angle in a wire. The discharges were made non-oscillatory in character, by introducing into the circuit a couple of strips of cloth such as is used for surgical bandages. These strips, which were in multiple, connected two tumblers containing salt solution, one of which was about 20 cm. above the other.

During about three weeks of use, a system of wavelets formed along the whole length of the wire. They were very uniform in dimensions. The wave-length was 0.090 cm., and the amplitude from crest to crest was 0.015 cm. The wire was under tension of four grams weight, by means of silk threads passing over pulleys.

The writer is under the impression that the irregular bending of wires traversed by a continuous current has been observed, but is unable to find a reference to it.

Francis E. Nipher

THE DATING OF PUBLICATIONS

To the Editor of Science: Through accident or policy, the Carnegie Institution has not dated many of its recent publications. In bibliographical citations, where dates are used to designate publications, it is difficult to dispose of papers where the time of publication is not given. Moreover, is it not desirable to date articles, to protect the writers in priority?

Max Morse
The College of the City of New York,
February 2, 1909

SCIENTIFIC BOOKS

Die Metamorphose der Insekten. Von P. Deegener. Pp. 56. Leipzig u. Berlin, B. G. Teubner. 1909.

This little book, by one who has written several valuable articles on the development of the alimentary tract of insects, is one of the most thoughtful and suggestive of a number of recent general accounts of Hexapod metamorphosis. The author adopts the now usually accepted view, advanced by Fritz Müller in 1864, that the larvæ and pupæ of insects represent cœnogenetic adaptations, the result of a tendency, so to speak, on the part of an originally monomorphic form, to become strongly trimorphic during its ontogeny. In other words, the more specialized insects (Holometabola) have found it increasingly advantageous to assume three successive forms during their metembryonic development: the first, or larva, being devoted to alimentation and growth, and often exhibiting peculiar modifications to suit the highly specialized environment in which it lives, the third, or imago, being devoted to the reproduction and dissemination of the species, and the second, or pupa, providing for the transformation necessitated by the two other very different stages.

Deegener's work is divided into three parts: an analysis of the organization of the larva, a consideration of the phylogeny of metamorphosis and of the significance of the pupal stage. He recognizes three kinds of larvæ:

the *imaginiform,* which occurs in the Ametabola (Heteroptera, Orthoptera) and is very similar to the imago into which it develops, the *semimaginiform,* which occurs in the Hemimetabola (Amphibiotica, some Homoptera) and is less similar to the adult, and the *true larva* of the Holometabola (Hymenoptera, Diptera, Coleoptera, Lepidoptera, etc.), which is succeeded by a quiescent pupal stage. The organs of the various larvæ are considered under the following heads:

1. Larval organs that are simpler than those of the imago but of nearly the same structure, or such as are absent in the imago but are nevertheless of a primitive character, as shown by comparison with their homologues in lower insects. Examples of such organs are the mouth-parts and antennæ of ephemerid larvæ, the cerci of campodeiform larvæ, non-pentameric tarsi, etc.

2. Organs that are more or less atrophied or vestigial in both larva and imago, *e. g.,* the labium and maxillæ of *Corethra* and *Chironomus,* the larval eyes of *Corethra,* etc.

3. Organs that were first acquired by the imago but subsequently transmitted to the larva, or that have taken on the imaginal form secondarily in the larva, like the sucking mouth-parts of the Hemiptera. To this category Deegener also assigns organs which appear in the larva as primordia of imaginal structures. These he calls *secondary imaginal discs,* in contradistinction to the *primary imaginal discs* which are represented by such structures as the wing-pads of the imaginiform and semimaginiform larvæ.

4. Organs that have been acquired by the larva independently of the imago and are either completely lacking in the latter (pedes spurii, sericteries) or have been acquired by it secondarily (external gills of some Perlids, rectal gills of Odonata, etc.). Such structures are designated as *provisional organs of the first order.*

5. Organs common to both larva and imago but developing in different directions in the two instars (sucking mandibles of the larval *Hemerobius, Chrysopa* and *Dytiscus;* digging legs of *Cicada* larvæ). Such structures are called *provisional organs of the second order.*

6. Organs that are typical or primitive portions of the insect organization but are completely retarded in their development during larval life and remain as primordia, or imaginal discs. These are called *tertiary imaginal discs* to distinguish them from the primary and secondary imaginal discs mentioned under (3). The gonads and their ducts, especially the latter, may be included under this sixth category, but in one sense they form a category by themselves, as they are not specifically insect organs and as the gonads sometimes mature during larval or pupal life.

Deegener calls attention to the fact that none of the organs of the imago is actually lacking in the larva, but that the latter may possess organs which do not occur in the imago. He concludes from this that the true larva "must be derived from the imago and hence presupposes the existence of the imago, and that therefore this is phylogenetically older than the larva, but that the true larva is younger phylogenetically than the imaginiform young of the Epimorpha and semimaginiform young of the Hemimetabola." This conclusion and Deegener's classification of larval characters would appear in a somewhat clearer light had he not neglected to take the embryo into consideration. A single example will make this statement clear. It is well known that certain embryonic organs, such as the thoracic appendages and antennæ, are lacking, as appendages, in the vermiform, or apod larvæ of many Hymenoptera, Diptera and Coleoptera, but are present again in the imago. This fact alone proves that the vermiform larva is an extreme cœnogenetic adaptation. It also throws light on another matter which Deegener, Heymons, Berlese and a host of other writers seem not to have clearly grasped, namely, the significance of the relations of the abdominal appendages of the embryo insect to the so-called prolegs (pedes spurii) of the larva. Deegener says of these:

> I assume that the pedes spurii do not arise directly by transformation from the appendages of polypod ancestors, and hence that they are not phylogenetic recapitulations (any more than are the tracheal gills) but are to be regarded as new

formations, which, however, have not originated independently of the vestiges of the abdominal appendages. The looseness of this dependence, however, is shown in certain Noctuid caterpillars, in which some of the pairs of prolegs make their appearance during larval life and hence at a time when the abdominal appendages have completely disappeared. I can not, therefore, regard the pedes spurii as primary, or even as resuscitated organs, but only as secondarily adapted provisional organs.

This statement if applied to the ontogeny would involve the unwarrantable assumption that the abdominal legs of the embryo disappear in the larva. This they do in many cases as hollow ectodermal evaginations filled with mesoderm, but they persist, nevertheless, as small, flat cellular areas in the ectoderm. In other cases, there is abundant evidence to show that they are directly transformed into the prolegs of the larva (Lepidoptera) and the gonapophyses of the larva or imago (Orthoptera). Where they are not thus transformed directly, but first flatten out, we obviously have the primordia of imaginal discs, and the organs would belong to Deegener's sixth category. Reverting now to the absence of antennæ and thoracic appendages in apod larvæ and their presence in the preceding or embryonic and the succeeding or imaginal instars, we see that we have a case of precisely the same nature as that of the abdominal appendages, though clearer on account of the larger size of the cephalic and thoracic structures and their imaginal discs. But any such ontogenetic conclusion as Deegener draws from the abdominal appendages of the Noctuid larvæ would here land us in the absurdity of supposing that the imaginal antennæ and thoracic legs of such insects as bees, weevils and ants are not completely homologous with their embryonic antennæ and thoracic legs. We are bound to conclude that all insect embryos are polypod and that the most ancient known Pterygogenea, the Palæodictyoptera, as Handlirsch has shown, had well-developed abdominal appendages, which must have been ambulatory in the more remote ancestors. It is, therefore, simpler to suppose, even if embryology did not furnish a great amount of evidence in support of this conclusion, that the ambulatory function has been revived in some of these appendages (pedes spurii of the caterpillars of Tenthredinidæ, Lepidoptera and Panorpatæ, pedes scansorii of Dipteran and Coleopteran larvæ), while others have become portions of the ovipositor and sting of the female insects, than to suppose that these various organs have come into existence *de novo* through modification of abdominal sclerites. This view, which is now fashionable in Germany, has arisen through ignoring or misinterpreting the conditions in the insect embryo, attaching undue importance to supposed homologies of the sclerites of adult insects and supposing that the organization of the Pterygogenea is to be interpreted by means of the Thysanura. It is a pleasure to see that Deegener departs from the conventional view to the extent of regarding the so-called campodeiform larva in the Holometabola as a secondary and not as a primitive type. In this respect his views coincide with those of Lameere, Boas and Handlirsch.

All entomologists will probably agree with Deegener that the characters peculiar to the larva have "arisen during metembryonic life successively in adaptation to differences in the conditions of the environment." He discusses at some length the reasons for the larval retardation in the development of the wings, and in this connection gives an interesting account of the subimago of the Ephemeridea, for the purpose of showing that an insect can actually undergo ecdysis after it has completely or almost completely developed its wings, but he does not emphasize the obvious fact that the wings of insects are organs primarily associated with the dissemination of the species, and, therefore, correlated ontogenetically with the maturation of the reproductive organs. The few larvæ that are pædogenetic (*Cecidomyia*) and the few beetles (*Pissodes,* Scolytidæ) that become imagines long before reproduction, though striking exceptions, can readily be explained as secondary adaptations. Attention is called to the reduction of the number of ecdyses and the manner in which pupation has become

associated with two of these in metabolic insects. The pupa of the Holometabola is regarded as being to a certain extent a phylogenetic stage, analogous to the subimago of the Ephemeridea, but as having developed its peculiarities (quiescence, unchanged external form and profound internal changes) in correlation with the structural differences that separate the larva from the imago. These differences are described as follows:

In the Hemimetabola the whole development appears as at first progressively imaginipetal (total habitus), later as temporarily and progressively imaginifugal (provisional organs), with ontogenetic adaptations, and finally as regressively imaginipetal (involution of the provisional organs). In the Holometabola, on the contrary, development is at first regressively imaginifugal (total habitus and imaginal organs), then progressively imaginifugal (development of provisional organs of first and second order) and finally (in the pupa) progressively (total habitus and imaginal discs) and regressively imaginipetal (involution of provisional organs). Hence the Holometabola are characterized in the metembryonic portion of their life cycle by a regressively imaginifugal type of development, which changes to the progressively imaginipetal type in the pupa. In other words: Whereas the continuously progressive development of the Hemimetabola is not interrupted and is only slightly affected by the formation of provisional organs, the progressive development of the Holometabola up to the imaginal stage suffers a long interruption (during the larval stage) and is not resumed till the transition to the first imaginal stage (the pupa), in order to attain, by passing through this, the definitive imaginal form.

Deegener, like many other students of insect metamorphosis, regards the pupa as a teleological development which enables the organism greatly to lengthen its larval life, and through the magnitude and intensity of the changes which it undergoes, to drop out or fail to recapitulate, a great number of phylogenetic stages and thus to pass directly into the adult condition. The development of such a pupal stage, he believes, has been facilitated by the ability, so frequently observed in insects, to fast for long periods of time. In this connection he might also have called attention to the adaptation of the pupal stage to tiding over unfavorable seasons (cold winters in temperate and boreal, dry seasons in tropical regions), as has been pointed out by Lubbock, Haacke, Handlirsch and others.

WILLIAM MORTON WHEELER

The Systematic Relationships of the Coccaceæ, with a Discussion of the Principles of Bacterial Classification. By CHARLES-EDWARD AMORY WINSLOW and ANNE ROGERS WINSLOW. New York, John Wiley & Sons. 1908.

The book before us is the completed results of work by these authors of which we have had preliminary information through articles in SCIENCE[1] and the *Journal of Infectious Diseases*.[2]

This work is by far the most important contribution to the purely scientific side of bacteriology which has appeared in a long time. It marks the beginning of a new era in bacteriological classification and nomenclature.

The systematic classification of the bacteria has always been extremely artificial and arbitrary. Outside of the three large morphological groups, the cocci, bacilli and spirilla, classification has probably never expressed natural relationships. However useful for purposes of identifying species artificial classification may be, it never reaches its highest function until it tells us more than whether a species has been previously described in the literature. It can never be really useful until it expresses for us the real position of the species in question in relation to other forms, and to some extent, at least, tells us the probable line of descent which the species has followed in its development from other forms. This is the ultimate goal which the classification of all living forms should seek.

A few attempts have been made to recognize certain "groups" among the bacteria, and undoubtedly some of these groups repre-

[1] "A Revision of the Coccaceæ," SCIENCE, N. S., XXI., 1905, 669.

[2] "A Statistical Study of Generic Characters in the Coccaceæ," Biological Studies by the Pupils of William Thompson Sedgwick, Boston, 1906; also *Journal of Infectious Diseases*, III., 1906, 485.

sent natural families or genera. Some of these groups are based on morphological distinctions while others are simply held together by certain physiological resemblances. And in practically all cases as soon as the firm ground of morphological characters is left, and attempts are made to make use of physiological differences, we find systematic bacteriology becoming simply determinative bacteriology, and all semblance of natural relationships is lost in a confusion most bewildering.

It has remained for the work of the Winslows to bring order out of chaos, to show us how it is possible to delimit the different groups of bacteria and to determine their natural relationships, with just as sure a footing, whether we make use of morphological or physiological characters.

Their method of defining bacterial groups is by a study of the numerical frequency of various characters in a large series of cultures. It matters not whether the characters are morphological or physiological as long as they are measurable. It is true this method of defining species is not original with these authors; anthropologists and students of variation and heredity have developed it for the study of their particular facts. Even among bacteriologists it was being used at the same time that the work of the Winslows was going on by Andrewes and Horder in England for the classification of the streptococci. But it was our present authors who pointed out the importance of this method for work with the bacteria, and it is to them that all credit should be given for working out the method and applying it on a large scale to the problem of bacterial classification.

It is not necessary here to refer to the method of biometry. It depends on the fact that fluctuating variations, when measured in a considerable number of individuals, group themselves in a curve which follows the simple mathematical law of chance. If two large arrays of individuals are measured the curves obtained are practically identical. But if arrays from different origins are measured the shape of the curves will differ, as well as the position and height of the modes. Such curves measure the peculiarities of a group as a whole, and serve to discriminate the different types, even though particular members of the groups are indistinguishable. By extending the observations to include the correlation of characters in the different racial types, the statistical method will indicate the systematic relationship of the different types.

As the authors themselves say:

> The biometric methods, which have proved so useful in the study of the races of man, promise to be of even greater value in the systematic analysis of types among the bacteria, where so many factors combine to preserve varietal differences on so wide a scale. If individual strains only are considered, an infinite series of differences appear. If the same strains are considered statistically, that is, if the frequency of a given character be taken into account, it is apparent that certain combinations of characters are much more common than others. Measurement of almost any character by quantitative methods shows that the bacteria examined group themselves on a simple or complex curve of frequency. The modes of this curve indicate centers of variation about which the individuals fluctuate; and these centers of variation are the real systematic units of the group. The recognition of such centers, as specific types, offers the natural and satisfactory compromise between systematic multiplicity and vague generalization. The grouping of specific types is an even more important problem than the definition of the types themselves; and here the correlation data obtained by biometric study are of assistance. A true natural classification is tree-like and includes branches and twigs of varying grades of importance. Genera of bacteria should be aggregates of those specific types which are most nearly related; and the basis of the relationship will differ in each individual case. . . . Finally, the results may be analyzed with two ends in view. First, each center of numerical frequency, marking a group of organisms varying about a distinct type in regard to a single definite property, may be recognized as a species. Second, those species which are bound together by the possession of a number of similar properties may be constituted as genera, and larger groups of genera, still characterized by some characters in common, may receive the rank of families or subfamilies.

The recognition of these principles will throw a flood of light upon all our future at-

tempts to classify the bacteria. It will give us a sound foundation upon which to build our systematic groups. It will give us a simple and natural nomenclature in place of the unwieldy generic names in use at present, and will do away with the tendency so noticeable now to use trinomial or even quadrinomial names.

Besides pointing out the proper way to work out the classification of the bacteria the authors have set us an example of just how to go about the work by their careful study of the Coccaceæ. They collected 500 different strains of cocci from different sources and submitted each one to a series of eleven definite, and in most cases, quantitative tests. The frequency curve for each character was plotted, the modes determined, and these modes were taken as the bases for the establishment of the various groups. The eleven characters were chosen after due deliberation and while there may be a difference of opinion as to the relative value of these characters and others which might have been selected, yet we must agree with the authors when they say that the eleven tests chosen furnished sufficient information to warrant the recognition of the most important natural groups. A further study of the correlation of these characters seems to point to the fact that these systematic units are marked by the general association of a number of independent characteristics. Such an association can be explained, our authors say, only on the ground of relationship, therefore the classification which they have arrived at is a natural one, and one which meets the requirements of expressing the natural relationships of the different groups.

The authors find eight genera among the Coccaceæ, each of which they define and discuss. To the bacteriologist familiar with the earlier classifications some very striking and totally unexpected results appear. First of these is the importance of pigment production as brought out by this method. Hitherto it has been taken for granted that such an easily modifiable character as the production of pigment was scarcely even of varietal rank. But a study of chromogenesis by the biometrical method shows that the production of the various pigments is the property of certain well-defined types, and when we take into consideration the singularly perfect correlation between this property and the fermentation of the sugars, and with other characters, we must agree with the authors that it is really of genetic significance. Second, we find that the authors lay little stress on such characters as the shape and markings of colonies on gelatin or agar, the shape of the liquefaction in the gelatin stab, the luster or surface appearance of agar streaks, characters which we have been in the habit of considering important. They show that for the most part these characters are but the result of differences in general vigor of growth and in the rate of liquefaction of the gelatin. They summon sufficient evidence to support their position so that we are forced to agree with them. But they are careful to state that their conclusions apply only to the Coccaceæ and that some of these characters may be found important when other groups are studied.

The book closes with a summary of the genera and species of the Coccaceæ, an admirable key to these genera and species, and finally a complete bibliography and author and subject indexes.

While the work on the Coccaceæ is most admirably done and gives us a working basis for all future study of these forms, yet its real worth is not in its own intrinsic value, but in its immense suggestiveness for all future work in the classification of other groups of bacteria. We hope that this will be but the first of a long series of monographs dealing with other groups of the bacteria, all worked out along the lines which these authors have so well marked out for us.

F. P. GORHAM
BROWN UNIVERSITY

A Treatise on Gold and Silver. By WALTER R. CRANE, Ph.D. New York, John Wiley & Sons. 1908.

The preface states that "The object of this work with others of a series is to give a complete and accurate record of the development

of the mineral resources of the country and its influence on the various industrial activities throughout the United States," and that it "has been prepared with aid received from the Carnegie Institution of Washington, and is to form part of the Economic History of the United States, which is to be published by that Institution. . . . The work has been conducted under the supervision of Mr. Edward W. Parker" and its preparation "has occupied two years," etc., from January, 1906, to January, 1908.

Perhaps the value of such a contribution is enhanced by its character as a compilation, and this may give some excuse for the repetition of details under different heads. But the very semblance of statistical quality emphasizes the advantages which might have accrued from the presence of an adequate index or an expanded system of paragraphing. So very much of laboriously collected material has been itemized in the 720 pages, that thousands of entries would be necessary to properly catalogue them. This work has but 500 references in the index, and these are mostly equivalent to the titles of broad divisions of the text. There are typographical errors in proper names of the west, some displeasing errors in grammar and rhetoric and other literary blemishes, but these can all be corrected in later editions and are much less conspicuous than would be the case but for the heavy proportion of quotations, in which these defects do not appear.

There are seven chapters, covering various aspects of gold and silver. The first deals in a semi-philosophical way with precious metal mining as "a factor in the industrial growth of the United States," crediting this industry very largely with the development of civilizing influences, by the inception of agriculture, extension of transportation facilities, expansion of finance, stimulation of scientific enterprises, the upbuilding of mining schools and the general development of the mining industry.

The history of the discovery and growth of precious metal mining and metallurgy is then given in great detail, by geographic divisions, followed by a full chronologic treatment, covering the period from 1513 to 1906.

This portion of the work bears evidence of painstaking library research, and probably the results are, all considered, as satisfactory as could have been anticipated by this method alone. It is cause for regret that an institution of the prestige of the Carnegie should not have availed itself of the services of reviewers in all parts of the country in order to preserve an even balance throughout the record. It is no disparagement to the able young author to suggest this; for he has performed uncommonly well an arduous task, in assorting his material and condensing it as he has done. The general impress is correct, remarkably so, indeed. Very few false conclusions are expressed, although some errors are apparent, which need not here be specified.

Chapter III. treats of "Occurrence and Association of Gold and Silver." It opens with a professedly cursory review of current theories of ore deposition, which is a model of perspicuity and a striking example of self-restraint in the presentation of the current aspect of a much-involved series of problems. The summary of it all is the quotation from A. G. Lock, which puts the case in a nutshell.

Following is a general discussion of the variety of mineral occurrences, ending with a review of prejudiced notions and their injurious effects upon the mining industry.

Then come 120 pages of detailed descriptions of occurrence, arranged alphabetically by states. This chapter gathers a vast array of facts, wholly unclassified and largely repetitive, but often useful in this form. There has been here no attempt to arrange this material more specifically, or to trace connection between the minor areas. Many more pages are taken up with the occurrence, geographically, of gold in gravels.

Only ten pages (chapter IV.) are given to the geologic distribution of gold and silver, and this deficit must be regarded as a blemish. It is true that the presentation in this concise manner bears abundant evidence of the author's thorough acquaintance with the subject

and of his ability to condense. But some might prefer the relegation of the prolix chapters which precede, to a separate volume, giving opportunity for more adequate treatment of subjects which appear to be slighted over much.

Chapter V. has 130 pages devoted to Mining Gold and Silver Ores and Gravels. This is well put together and presents a very fair outline of methods of mining, being very largely a series of quotations from leading authorities, although in some parts the author exhibits his own qualifications by presenting well-digested material in his own words.

In chapter VI. a similar arrangement of authoritative quotations, edited and connected by appropriate remarks, makes a generalized review of about 80 pages.

Nearly 100 pages (as chapter VII.) are given to statistics of production, compiled by geographic areas, as usual. This work has been well performed. Six appendices follow in the form of tables, recapitulating in detail the statistical matter previously given, under practically equivalent headings. These crowd a vast amount of particular information into little more than 60 pages, but they are by no means as complete as they might have been made by seeking the aid of many local co-laborers. As a convenient hand-book for ready reference by busy practitioners, the statistics and much of the technical matter quoted may be in useful form, and probably the whole will fill a want among the untutored who require pre-digested nutriment. The abundant references, though lacking the personal factor which would ordinarily attest their authority, add greatly to the value of the work.

The compiler has rendered good service faithfully and conscientiously, according to a plan apparently dictated by others. Perhaps it is premature to express any opinion upon certain features which might be otherwise rated if one really knew the purpose of the Carnegie Institution in having prepared the series of texts of which ostensibly this is the forerunner. For instance, under the head of Extraction of Values, no mention is made of the flux smelting of gold and silver ores, concentrated in lead and copper menstrua. Although it is probable that this has been reserved for future volumes of the series, where the discussion may be more appropriate, there appears throughout the present volume a tendency to minimize the importance of the fact that the actual weight of silver annually extracted from placers and dry ores amounts to nearly four and one half times the weight of gold obtained from the same source. This is not an economic argument, to be sure, in favor of more generous treatment of the minor metal in a work purporting to deal with both. But the facts are that the weight of all silver extracted amounts to about fourteen times the weight of the gold, and that much more than three fourths of the total silver product (equal in value to one third of the gold product) is won by metallurgic processes designed primarily for the recovery of the silver. Moreover, the metallurgy of the baser ores, *per se,* is in many respects so distinctive that the collection of gold and silver therein is to be regarded properly as a separate industry. That is to say, the presence of the precious metals in ores limits and defines processes of treatment in such a manner as to make the grosser metals the real by-products.

Therefore, it would seem logical and profitable to discuss some methods to which little or no reference has been made in Dr. Crane's work.

Keeping always in mind the introductory words of this review, if it be fair to judge by them alone, the author appears to have compassed very well the task set by the Carnegie Institution. Probably no one else was better placed to perform this identical service by the means employed in executing it. One might prefer a different mode of treatment and the enlistment of others in the collaboration of data not readily accessible in print. But criticisms of this kind must not be permitted to obscure the patent fact that the writer appears to the very best advantage in those parts in which his subjects have given him more free scope for the exercise of his own abilities, and where dictates of modesty and

honor have not appeared to make rigid quotation essential.

Theo. B. Comstock
Los Angeles, Cal.,
January 15, 1909.

Ueber das Wesen der Mathematik. Rede gehalten am 11 Marz, 1908, in der öffentlichen Sitzung der k. Bayerischen Akademie der Wissenschaften. Von Dr. A. Voss, Professor der Mathematik in München. Pp. 98. Leipzig und Berlin, B. G. Teubner. 1908.

The numerous and valuable earlier publications of the author of the present address inspire confidence in his ability to treat such a general subject in a scholarly and helpful manner. The reader will find that this confidence has not been misplaced, for the address is not only replete with important suggestions in regard to fundamental questions in mathematics, but it also emphasizes those elements which point towards rapid progress in the near future and thus awaken a healthy optimism. It seems especially suited to widen the outlook and to arouse energizing enthusiasm on the part of the young mathematician who may fail to appreciate the dignity and the beauty of abstract thought.

The author begins his address by the statement that we are living in the epoch of natural sciences and technology, and he quotes approvingly the remarks of Galileo:

> True philosophy explains nature, but no one can understand her except those who have learnt the language and the symbols by means of which she speaks. This language is mathematics and the symbols are mathematical figures.

The bearing of mathematics just mentioned tends to explain why this subject is constantly taking deeper root in the educational systems of the world, notwithstanding the fact that it is "the most unpopular of all the sciences; it is a part of the essence of a true science to be unpopular."

The brief introductory remarks are followed by a rapid sketch of some fundamental facts in the history of mathematics. Beginning with the Egyptian work, written by Ahmes nearly four thousand years ago, which claims to give "Directions to obtain a knowledge of all dark things, all secrets contained in the things," our author considers the historical development of a number of fundamental mathematical concepts and symbols. He generally follows the "Prince of mathematical historians," Moritz Cantor. In one instance, however, he adopts a view which is not in accord with the most recent work of Cantor, viz., as regards the question of the origin of zero and the positional arithmetic. Ten years ago it was generally believed that these discoveries were due to the Hindus, while the most recent work of Cantor makes a Babylonian origin appear much more plausible.

As may be inferred from the heading of the address, emphasis is placed upon those mathematical concepts which border on the domain of philosophy. Among the questions which receive considerable attention are the following: definitions of mathematics, relations between mathematic and logic, the development of the concept of number, higher complex number systems and different points of view as regards ordinary complex numbers, different theories in regard to ordinary fractions and irrational numbers, continuity and limit, importance of the concept of function, and suggestions as to changes in the subject-matter to be used for instruction in secondary schools. The address is written in a popular style and should interest the man of general culture as well as the professional mathematician.

G. A. Miller
University of Illinois

SCIENTIFIC JOURNALS AND ARTICLES

The Journal of Experimental Zoology, Vol. VI., No. 1 (January, 1909), contains the following papers: "A Study of Growth in the Salamander, *Diemictylus viridescens,*" by Ada Springer. "Studies on Chromosomes—IV., The Accessory Chromosome in *Syromastes* and *Pyrrochoris,* with a Comparative Review of the Types of Sexual Differences of the Chromosomes," by Edmund B. Wilson. This paper is devoted to a reexamination of two forms heretofore studied by Gross. It shows that sex-production in these forms agrees in principle with that seen in other insects. In *Pyrrochoris* the spermatogonial number is 23

and a typical odd chromosome is present. In *Syromastes* the spermatogonial number is 22, the "accessory" being represented by two chromosomes, and the number 24 is inferred for the female. A general review is given of the facts thus far determined in this field. N. M. Stevens contributes "Further Studies on the Chromosomes of the Coleoptera" and "An Unpaired Heterochromosome in the Aphids." David Day Whitney writes on "The Effect of a Centrifugal Force upon the Development and Sex of Parthenogenetic Eggs of *Hydatina senta*." The unsegmented eggs were centrifuged so that their contents were separated into three layers. These layers were variously arranged in their relation to the first cleavage plane and consequently a different distribution of the egg material occurred in each of the cells at the first cleavage. From such eggs normal individuals developed, grew to maturity, and produced normal offspring. No change in the sex ratio occurred. The same author has an article on "Observations on the Maturation Stages of the Parthenogenetic and Sexual Eggs of *Hydatina senta*." In the female parthenogenetic egg there is no reduction in the number of chromosomes during maturation but in the male parthenogenetic egg and also in the fertilized egg there is a reduction in the number of chromosomes. One polar body is formed by the female parthenogenetic egg and two polar bodies are formed by the male parthenogenetic egg.

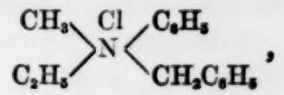
A NEW VARIETY OF ASYMMETRY EXHIBITED BY THE NITROGEN ATOM

A NUMBER of organic compounds are known the isomerism of which is due to the different spatial arrangement of certain groups around a nitrogen atom. The most familiar examples are the oxines, such as benzaldoxine, which exists in the forms,

$$C_6H_5CH \quad \text{and} \quad C_6H_5CH,$$
$$NOH \qquad\qquad HON$$

termed the *syn-* and *anti-* modifications, respectively.

A second variety of isomerism is recognized which is dependent on the fact that the nitrogen atom is linked to five dissimilar groups, as, for example, in the compound,

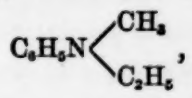


which exists in three forms. One is optically inactive (racemic) and the other two rotate the plane of polarized light to the right and left, respectively.

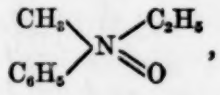
Similar varieties of isomerism are, of course, common in the case of analogous carbon compounds free from nitrogen.

Hitherto it has been believed that the difference in optical behavior mentioned above could not be exhibited unless all five of the groups linked to the nitrogen were unlike, but J. Meisenheimer[1] has just shown that this is not the case.

When methylethylaniline,

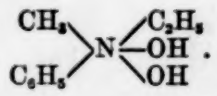


is treated with hydrogen peroxide, in presence of sulphuric acid, methylethylaniline oxide,



is formed. It is a crystalline, basic substance and is optically inactive. By the fractional crystallization of its *d*-bromcamphorsulphonic salt it is separated into two modifications. From these the corresponding free bases may be isolated and other salts prepared. These free bases are relatively stable and they rotate the polarized light to the right and left, respectively, the rotation being equal in degree.

It is, at present, uncertain whether these optically active free bases have the anhydro formula given above, with the double linkage between nitrogen and oxygen, or whether they are dihydroxides,



In either case, however, the isomerism is of an entirely new type. It will be interesting to see whether it is possible to prepare analo-

[1] *Ber. deut. Chem. Ges.*, 41, 3966, 1908.

gous compounds of the carbon series, free from nitrogen.

J. Bishop Tingle

McMaster University,
Toronto, Canada,
December 16, 1908

RUSSIAN RESEARCH IN METABOLISM

The activity of Russian investigators in problems of animal nutrition and metabolism in general has been but imperfectly noted by the large majority of workers in metabolism. This is in large part due to the fact that in spite of increasing interest in international cooperation in scientific research in all branches, the Russian language remains, and probably will continue to remain, a distinctly unintelligible vehicle for conveying scientific communications to the world at large. More recently at least one Russian journal is issuing simultaneously an edition in French.

Recognizing the great importance of many of the earlier Russian researches, the Office of Experiment Stations of the U. S. Department of Agriculture has from time to time had translated and published abstracts of much of the Russian research in that particular branch of science dealing with metabolism. These abstracts were translated in large part by Professor Peter Fireman, formerly of the George Washington University, and the admirable digest of metabolism experiments by Atwater and Langworthy[1] contains many of them.

A dissertation entitled "Production of Heat by Healthy Man in the Condition of Comparative Rest," by A. Likhachev, is especially valuable as giving a complete description and tests of the Pashutin respiration calorimeter. This was translated at the instance of the Office of Experiment Stations, U. S. Department of Agriculture, by Dr. Fireman. Copies of the translation are on file at the Nutrition Laboratory and also at the Office of Experiment Stations, U. S. Department of Agriculture.

In connection with the preparation for publication of the results of a series of experiments on fasting men made at Wesleyan University, I arranged with a young Russian school teacher, H. Levin, to translate completely a lengthy article entitled "Metabolism during Fasting," by A. Sadovyen. This article is of interest in that it describes a series of experiments on a fasting man in the Pashutin respiration chamber. The translation is preserved in the reading room of this laboratory.

On a recent visit to a number of European laboratories it was my good fortune to include several of the laboratories in St. Petersburg, and there I came into intimate contact with a great deal of research which was to me wholly unknown. I found that in certain instances the briefest kind of an abstract had been noted in some of the German abstract journals, but nothing approximating an adequate digest of this work had appeared as yet in anything but Russian. Thanks to the kindness of Professors Likhachev and Avroroff and Dr. Kartaschefsky, many important monographs were placed in my hands and, on my return to America, arrangements were made for their translation.

Professor Likhachev sent to the Nutrition Laboratory a copy of Pashutin's treatise on experimental pathology. This large work, consisting of two bulky volumes, contains a great deal of new, unpublished material, particularly in the section (some 800 pages) dealing with inanition. During the past year the whole section on inanition has been completely translated by Michel Groosenberg. This valuable work contains a large amount of original material, chiefly from Albitsky's laboratory, and is of importance to all workers in animal or human nutrition. The translation has been typewritten, manifolded and bound and copies of this translation are deposited in the surgeon general's library in Washington, the New York Public Library, and in the John Crerar Library in Chicago. Two other monographs presenting the results of experiments on man in the Pashutin respiration calorimeter are "The Influence of Alcohol on the Heat and Gas Exchange in

[1] Bulletin 45, Office of Experiment Stations, U. S. Department of Agriculture, 1898.

Man" and "Investigations of Gas and Heat Exchange in Fevers," both by A. Likhachev and P. Avroroff. Finally, two articles by Dr. Kartaschefsky reporting experiments with the small Pashutin respiration apparatus have been translated. They are entitled "The Influence of a Lack of Oxygen on the Exchange of Matter and the Heat Production in Animals" and "On the Influence of the Surrounding Temperature upon Animals in a Gas-Atmosphere poor in Oxygen."

These articles were translated in part by Mr. Alexander Rose, of Boston, Mr. Michel Groosenberg and Miss Anna Monossowitch, who is at present engaged in Russian translation at the Nutrition Laboratory.

Thus it is hoped to keep American workers in nutrition in more intimate contact with the admirable Russian researches that have as yet been practically inaccessible. Arrangements have been made with Professor Likhachev whereby all articles dealing with problems of metabolism can be sent to this laboratory for translation. From time to time the titles and short abstracts of these articles will be published in some scientific journal.

FRANCIS G. BENEDICT
NUTRITION LABORATORY,
CARNEGIE INSTITUTION OF WASHINGTON,
VILA STREET, BOSTON, MASS.

SPECIAL ARTICLES

A MENDELIAN VIEW OF SEX-HEREDITY

Two important contributions have recently been made to the discussion of sex-inheritance. In each a somewhat different view is presented, yet the two, I believe, are not irreconcilable, and if coordinated, will give us a truer conception of the whole matter than we have had before. I refer, on the one hand, to the recent vice-presidential address of Professor Wilson,[1] and, on the other, to the combined work of Bateson, Punnett, Doncaster, Durham and Marryat, published in Report IV. to the Evolution Committee of the Royal Society.

In 1903[2] I advocated the view that sex is inherited as a Mendelian character. The idea was not original with me. The suggestion came from the now famous Report I. of Bateson and Saunders. The fact has since come to light through Mendel's posthumously published letters[3] that Mendel himself had been impressed by the parallelism between the phenomena of sex-inheritance and those of ordinary Mendelian inheritance. Indeed, the parallelism is so complete and striking that we can scarcely question the existence of a like basis for the two sets of phenomena.

Professor Wilson, to be sure, argues against what he terms "Mendelian theories" of sex-heredity and advances a somewhat different theory of his own. In reality, however, his theory, while an improvement upon its predecessors, is no less Mendelian than they, but rather more so, as I shall attempt to show.

Great advance has been made since 1903 in our knowledge of Mendelian inheritance in general, as well as of sex-inheritance, and it is noteworthy that in restating our knowledge in the two fields similar changes must be made in both. For example, we formerly said regarding crosses between rodents of different colors that "gray is dominant over black" and that "black is dominant over yellow," meaning that the contrasted characteristics were antagonistic and one excluded the other in crosses. As we now look at the matter, gray is not antagonistic to black, but contains an additional element which is wanting in black. The correctness of this view is shown by the fact that black can be changed to gray by a cross which introduces that additional element. A similar relation holds between black and yellow; black is yellow plus something else, and this something else may actually be added to yellow (by a cross with brown, for example) converting it into black.

Similarly as regards sex, in 1903 I expressed the view that male and female are antagonistic members of a Mendelian pair, one excluding the other. Such a view is inadmissible in the light of our present knowledge. What we should say is that the female is the male condition plus something else. Male-

[1] SCIENCE, January 8, 1909.

[2] *Bulletin, Mus. Com. Zool.*, Vol. 40, p. 189.

[3] *Abh. math.-phys. Klasse d. k. Sachs. Gesellsch. d. Wiss.*, Bd. 29, p. 185, Leipzig, 1905.

ness is not, then, the Mendelian allelomorph to femaleness, but a differential factor between male and female is allelomorphic to absence of that factor. Presence of that factor means femaleness, absence of it means maleness. This differential factor is inherited as a Mendelian character dominant over its absence.

Such a statement will, I believe, bring into harmony the seemingly discordant results of Wilson, of Correns, and of Bateson and his associates. For Correns urges the view, as I did in 1903, that the male and female sex-characters as such are inherited. He believes further that the female organism is a homozygous recessive (♀♀) and the male a heterozygous dominant (♂♀), for he finds that the egg-cells of *Bryonia dioica* all transmit a female sex-tendency, whereas the pollen cells transmit, half of them the female tendency, half the male tendency. His facts are unquestionable. I question only the supposed recessive nature of the female sex-character.

Wilson cautions us against the view that sex as such is inherited, believing that the difference between the two sexes is in reality a quantitative one. He finds the female characterized by the possession of two X-chromosomes, the male by one, and regards a second x-chromosome as the differential factor between male and female. In the view that the essential difference between the sexes is a quantitative one, Wilson makes general an assumption made earlier by Morgan[4] for a particular case.

This suggestion seems to me very helpful. Among other things, it clears up fully the long mysterious matter of sex-determination in the honey bee, of which I gave in 1903 an interpretation since proved to be wrong. But though we regard the distinction between male and female as quantitative, we must not forget that it is discontinuous. *The female is the male condition plus a distinct unit-character Mendelian in heredity.*

We must also not follow Professor Wilson too closely in his assumption "that a single X-element in itself causes or determines the male tendency, while two such elements in association create, or at least set free, the female tendency." For we shall presently see reasons for believing that in certain cases *one* X-element may determine the female tendency, while *no* X-element may determine the male tendency. But in both categories of cases alike the essential difference between male and female would seem to be one X-element, which the female possesses over and above the male.

We may leave open the question whether or not the "X-element" of Wilson is the actual material basis of this differential Mendelian unit-character of sex. The X-element at least behaves in cell-division as we must suppose that the basis of a Mendelian character would behave, and it will be convenient in what follows to treat it as actually representing such a basis.

Wilson's hypothesis will account satisfactorily for the experimental results of Correns, for it necessitates the production in gametogenesis of eggs all alike in sexual tendency, bearing X, but it calls for the production of spermatozoa of two different sorts, half of them bearing X, half of them without X. Eggs fertilized by the former should produce females (XX), those fertilized by the latter should produce males (X). Correns's observations accord with this interpretation.

But the Wilson hypothesis breaks down if we attempt to extend it to the cases discovered by Bateson and his associates. For in these it is evident that the eggs, not the spermatozoa, are dimorphic in sex tendency, whereas the spermatozoa are all alike. We can not reconcile such a condition with the hypothesis that XX produces a female, X a male. But the condition in question does harmonize with the assumption, X = a female, no-X = a male, and this condition, no less than that described by Correns for Bryonia, agrees with the more general assumption that the female possesses one more X-element than the male.

The cases to which reference has been made in which the female produces eggs with different sex-tendencies, but spermatozoa all with

[4] Science, Vol. 21, 1905; *Am. Naturalist*, Vol. 41, p. 715, November, 1907.

the same sex-tendency, are, first, the moth, *Abraxas grossulariata,* and, secondly, the canary-bird. The two cases appear to be similar, but as the former has been more fully worked out, we may confine our attention to that. The case of *Abraxas* has already been presented in part to the readers of SCIENCE by Bateson and Punnett.[5]

This moth has a rare variety, *lacticolor,* known originally only in the female sex. For brevity in description we may call the typical *grossulariata* condition G, and the *lacticolor* condition L. The latter is a Mendelian recessive to the former.

Cross 1.—The cross L♀ × G♂ gives only G offspring in both sexes, but of course all bearing L as a recessive character. See Table I.

Cross 2.—Heterozygotes (produced by cross 1), when bred inter se, produce G♀, G♂ and L♀, but in no case L♂ offspring.

Cross 3.—A heterozygote G♂, mated with L♀, produces all four possible combinations, G♀, G♂, L♀ and L♂. "The L♂s thus produced were the first that had ever been seen." Now comes the most remarkable part of the whole story.

Cross 4.—When the newly produced L♂s were mated either with heterozygous G♀s produced by cross 1, or with wild G♀s, the offspring were all G in the male sex, all L in the female sex.

Cross 1 establishes beyond question the recessive nature of the color character L. Cross 4 shows that the G♀, whether cross-bred or wild in origin, is heterozygous in color-character, bearing L as a recessive character. No homozygous G♀s have been found. Crosses 1 and 3 show that the male may be, as regards character G, either homozygous, GG, or heterozygous, GL, and cross 3 shows that it may also be homozygous in L, that is, LL. In other words, there is no correlation between the male sex-character and either color-character. There does, however, clearly exist repulsion between the female sex-character and the color-character G, so that, whenever an alternative is offered, femaleness and L go into one gamete, maleness and G into another. But such alternatives manifestly occur only in oogenesis, not in spermatogenesis. In no other way can we account satisfactorily for either the difference in result between the reciprocal crosses, 1 and 4, or the failure of cross 2 to produce the group L♂.

Bateson completes the explanation by offering the further suggestion that there is no disjunction of the sex-characters in spermatogenesis because the male does not carry the female sex-determiner at all, but is homozygous, ♂♂. Consequently, when the L character once gets into a male individual, as by cross 1, where heterozygous GL♂s are produced, then in the spermatogenesis of such an individual gametes are sure to be formed in which the male character is associated indifferently either with G or with L. This, however, permits of the production of (homozygous) L♂s only in cases where the egg bears the ♂ character associated with L, a condition realized in cross 3, but not in cross 2 or cross 4. Doncaster summarizes the case in a table, which is here reproduced as Table I.

TABLE I

Abraxas crosses, Doncaster's interpretation

	Parents	Constitution	Gametes	Offspring
Cross 1	*Lact.* female	LL ♀ ♂	L♀, L♂	GL ♀ ♂ = *gross.* female
	Gross. male	GG ♂ ♂	G♂, G♂	GL ♂ ♂ = *gross.* male
Cross 2	Heterozygous female	GL ♀ ♂	L♀, G♂	GL ♀ ♂ = *gross.* female LL ♀ ♂ = *lact.* female
	Heterozygous male	GL ♂ ♂	G♂, L♂	GL ♂ ♂ = *gross.* male GG ♂ ♂ = *gross.* male
Cross 3	*Lact.* female	LL ♀ ♂	L♀, L♂	GL ♀ ♂ = *gross.* female LL ♀ ♂ = *lact.* female
	Heterozygous male	GL ♂ ♂	G♂, L♂	GL ♂ ♂ = *gross.* male LL ♂ ♂ = *lact.* male
Cross 4	Heterozygous female	GL ♀ ♂	L♀, G♂	LL ♀ ♂ = *lact.* female
	Lact. male	LL ♂ ♂	L♂, L♂	GL ♂ ♂ = *gross.* male

If, in Table I, we substitute X for the symbol ♀, discarding the symbol ♂ altogether, and consider all individuals bearing X to be

[5] Vol. 27, p. 785, May 15, 1908.

females, we get no change in the character of the results shown in the column headed "offspring." See Table II. That is, the facts

Table II

Abraxas crosses, an alternative interpretation

	Parents	Constitution	Gametes	Offspring
Cross 1	*Lact.* female *Gross.* male	LLX GG	LX, L G, G	GLX=*gross.* female GL=*gross.* male
Cross 2	Heterozygous female Heterozygous male	GLX GL	LX, G G, L	GLX=*gross.* female LLX=*lact.* female GL=*gross.* male GG=*gross.* male
Cross 3	*Lact.* female Heterozygous male	LLX GL	LX, L G, L	GLX=*gross.* female LLX=*lact.* female GL=*gross.* male LL=*lact.* male
Cross 4	Heterozygous female *Lact.* male	GLX LL	LX, G L, L	LLX=*lact.* female GL=*gross.* male

agree with the hypothesis, X = ♀, no-X = ♂, quite as well as with the Bateson-Doncaster hypothesis. But if we apply Wilson's XX = ♀, X = ♂, hypothesis to the case, the expectations for crosses 3 and 4 will be exactly interchanged; cross 3 should produce only L♀s and G♂s, whereas cross 4 should produce all four possible combinations. This fact is decisive against the Wilson hypothesis and for that of Doncaster, or for such a modification of it as I have attempted to present.

We may, it seems to me, summarize our present knowledge of sex-inheritance under one consistent scheme, somewhat as follows:

1. Sex is not directly controlled by the environment, but is determined by internal (gametic) factors.

2. The determination of sex depends upon the presence in the zygote of a factor or factors which are inherited in accordance with Mendel's law.

3. Femaleness, that is, the capacity to produce macrogametes (eggs) depends upon the presence of some factor wanting in the male.

4. The presence of this factor is in heredity dominant over its absence.

5. As regards the transmission of this factor we can recognize two distinct categories of cases:

A. Femaleness is attained only when the differential factor is doubly represented in the individual. In such cases the female is a homozygote (XX), and the egg invariably transmits the differential factor. Sex determination then rests with the male parent, for half the spermatozoa possess the differential factor and half lack it. The female is a homozygous dominant, not, as Correns supposed, recessive; whereas the male is a heterozygous dominant, pure recessives being unknown.

B. Femaleness is attained whenever the differential factor is present in one only of the conjugating gametes which produce the individual. The gamete which transmits the differential factor is of course the macrogamete (egg), since this factor is not possessed by the male parent. The female is a heterozygous dominant, the male a pure recessive; homozygous dominants are unknown.

The experimental proof for the existence of these two categories of cases has been produced for class A by Correns, and for class B by Doncaster and others. Cytological evidence which strongly supports the interpretation given to class A has been produced by McClung, Stevens, Morgan and especially by Wilson. This evidence is fully corroborated by the work of many others. Direct cytological evidence for the existence of class B is not known at present, but may confidently be looked for.

6. The hypothesis which I advanced in 1903, that both sexes are in the same species sex-heterozygotes, is not supported by the considerable body of evidence since accumulated.

If, as seems probable, the differential sex-character has its cytological basis in the "X-element," as Wilson designates it, it becomes an interesting question, what is the cytological basis of those numerous morphological characters possessed by the male, but wanting in the female. For it is a well-known fact that such secondary sexual characters are in general both more numerous and more striking in the male than in the female. For this reason the male has been called the "progressive" sex, which takes on new or striking characters, that may or may not later be

shared with the female. Can we reconcile these facts with the idea that the female is a male plus something else? I think so, but we must concede also the possibility that the male may possess certain qualities not merely not manifested by the female, but even not possessed by it. I would offer the suggestion that we have a mechanism suitable for the transmission of characters exclusively male in the Y-element described by Wilson, the "synaptic mate" of the X-element, which takes the place in the gamete of a lacking X-element, and which would not be borne by a gamete possessing that element. If the primary difference between male and female is a defect in the male, the lack of something present in the female, that very defect would constitute a likely place in the germ-cell for new structures to find lodgement, which, behaving as the "synaptic mate," the material counterpart of the X-element would pass only into gametes lacking X, and so would produce structures peculiar to the male, and unrepresented in the female.

If this idea should prove to be correct, then we should have to revise the generalization to which Wilson gives expression "that so far as the eggs are concerned (and also those spermatozoa that contain the X-element) . . . every gamete contains factors capable of producing both the male and female characters, and that this is also true of all the zygotes." If the Y-element should prove to be the basis of characters purely male, then such characters would not be represented at all in gametes containing X, and cases like that described by Darwin, in which the hen-pheasant transmits to its hybrid male offspring in crosses characters of the male of its own species, could have but one interpretation, viz., that the hen-pheasant produces gametes lacking the X-element, as well as those which possess it. In other words, the hen-pheasant would seem to be a sex-heterozygote and so to fall in the same category of cases as the moth, *Abraxas grossulariata,* category B already mentioned. If so, the male pheasant should be incapable of transmitting in crosses characters peculiar to the female pheasant, if such exist.

This line of thought emphasizes the importance of reciprocal crosses in unraveling the mysteries of sex-inheritance and of the inheritance of secondary sexual characters. If the two categories of cases A and B really exist, there should be this difference between them. In A the male may transmit recessive characters peculiar to the female, but the reverse relation does not hold. In B, the female may transmit recessive characters peculiar to the male, but the reverse relation does not hold.

Further, there should be a difference in the two categories of cases in the Mendelian nature of fixed sexually dimorphic conditions. In category A, male secondary characters must be dominant in order to be fixable, *i. e.,* they must be represented in the Y-element by something not found in the X-element, but which will manifest itself even in the presence of the X-element. In category B, male secondary characters must be recessive in order to be fixable, *i. e.,* they must have their basis in the absence from Y of some element present in X, which absence will not be manifested if even a single X-element is present. For example, in *Abraxas* the pale *lugens* character is manifestly a defect character, due to lack of something found in *grossulariata* individuals, L being recessive to G. The gametic coupling of the female character with the *lugens* character, whenever a doubly differential cell division occurs, is doubtless due to the fact that the *grossulariata* character acts as the "synaptic mate" to the X-element, leaving absence of G (*i. e.,* L) associated with X. If in this cell-division G were associated with X, instead of with Y, then it would be possible to produce a stable sexually dimorphic race, with L♂s and G♀s, but the relation being what it is, no stable race can be formed in which the two sexes are G and L, respectively, but only races purely G or purely L in both sexes.

On the hypothesis suggested in this paper, accordingly, we can account for the fact that secondary sexual characters are more common in the male, if not its exclusive possession, even though the male is, as compared with the female, a defect race, or regressive variation. Transference to the female of characters originally possessed by the male alone could be accounted for by the duplication of the Y-element

in a heterozygous (XY) germ cell. In this case Y would become the "synaptic mate" of Y, and X would be left once more (as originally) without synaptic mate, fit instrument for the origin of new progressive variations, the characters determined by Y now being the common property of both sexes.

A clue to phylogenetic histories would thus be afforded us, giving point to such variations as the *lugens* variety of *Abraxas*. Thus it is possible (though nothing but pure speculation in the light of our present knowledge) that *lugens* may be the phylogenetically older form, characteristic originally of both sexes, and that the *grossulariata* character may have had its beginning in gametes lacking the X-element, *i. e.*, in a Y-element formed as the "synaptic mate" of X. Thus would arise *grossulariata* males, but the new character being dominant over its antecedent (*lugens*) would quickly be transferred to the females, since these contain a no-X (*i. e.*, a Y) element, in common with the males. But the X-element, as shown by Doncaster's experiments, is still unassociated in a gamete with the new *grossulariata* character, and so the fixing of that character upon the species is not yet complete.

How now may the occasional reappearance of *lugens* females be accounted for? Simply by reduction divisions, in spermatogenesis, in which the two Y-elements fail to segregate as normally, forming in consequence a sperm-cell which lacks Y (the *grossulariata* character). If such a sperm-cell fertilizes an egg of the constitution LX, a *lugens* female is certain to result.

If, as has been suggested, the presence in one gamete and absence from another produced by the same cell-division, of an "odd chromosome" (or other X-element, whether chromosome or something else) is itself a circumstance which favors the origin of new characters in the defective (male-forming) gamete, then we shall perhaps come to attach less importance than has sometimes been done to the supposed influence of sexual selection in evolution. For sexual selection, as has often been pointed out, can in no case account for the origin of new characters, and it is extremely doubtful whether it plays any part even in their preservation.

Striking new characters produced by internal causes doubtless persist unless suppressed by external causes, *i. e.*, unless they disqualify their possessor for competition in the struggle for existence. There is no more reason for supposing that males gain their gay colors and markings from choice on the part of the females, than that females owe their modest colors to choice on the part of the males. But if, as suggested, the very mechanism of gametogenesis is adapted for the production of new characters in the male, then we are afforded a basis for their explanation, without invoking external causes. Recent investigations tend strongly to show that variations of evolutionary significance are primarily internal. This is unmistakably so in the matter of sex. Even in cases where sex is subject to control by environmental factors, as in aphids and daphnids, the environment acts indirectly apparently through the control of the same internal factors which govern sex in other animals. If the mechanism which I have suggested is not their true source, then we may well look for other possible internal mechanisms.

Orthogenesis also, the persistent tendency of an organism to vary in a particular direction, irrespective of the action of natural selection (if indeed orthogenesis be a reality, which, however, I do not assert), orthogenesis then would find an explanation along similar lines to those which I have suggested. For if a Y-element arose because of the very lack of X, then it would be natural for it to continue to grow until it became the full complement of X.

I make no apology for offering the hypothesis, or hypotheses, contained in this paper. I would have every reader recognize as fully as I do that they are hypotheses, and I shall be quite content if they suggest lines of investigation which will further elucidate the nature of sex and the manner of its inheritance.

W. E. Castle

Zoological Laboratory,
Harvard University,
February 10, 1909